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SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

EDITORS
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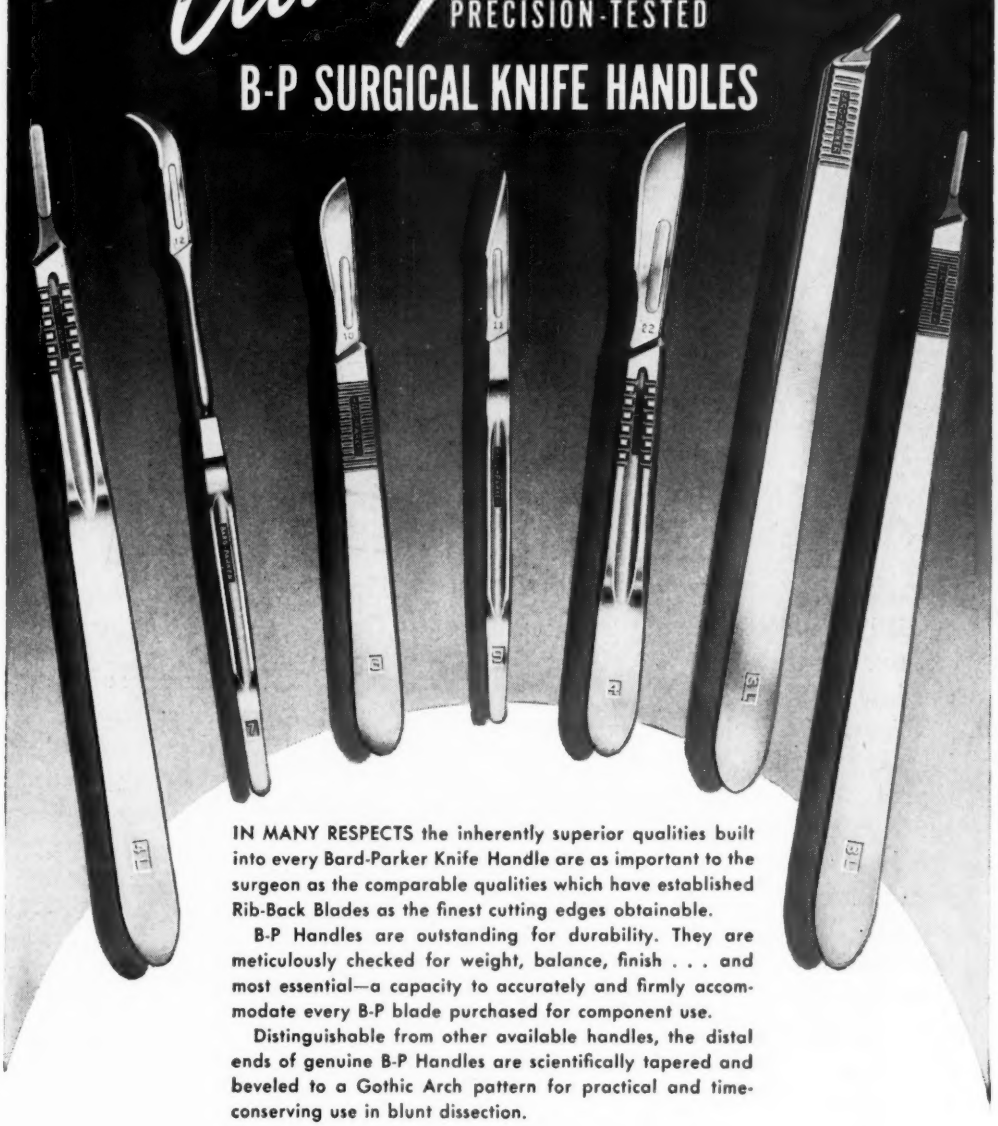

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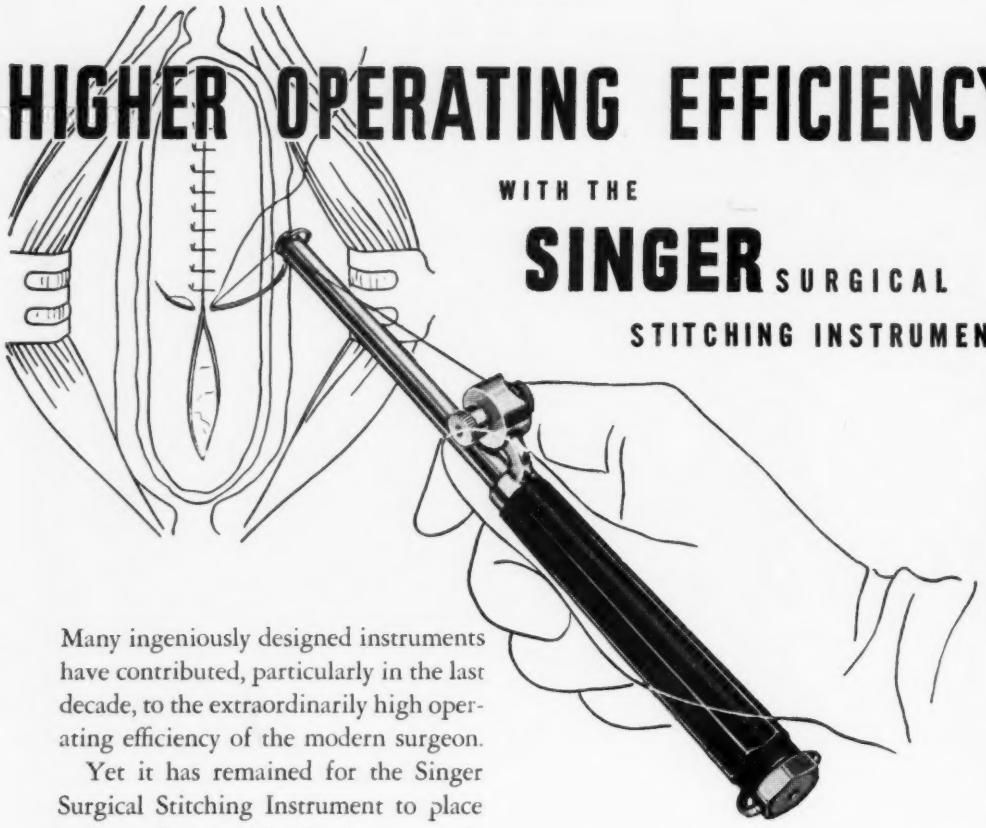

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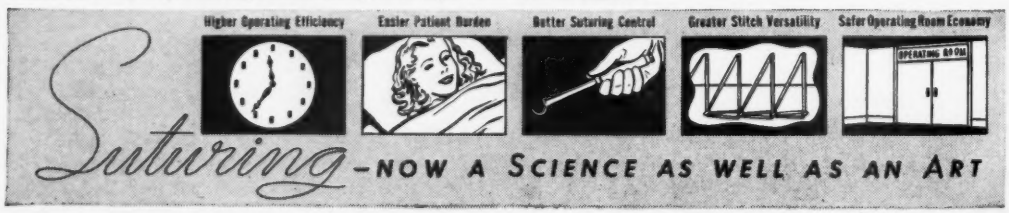

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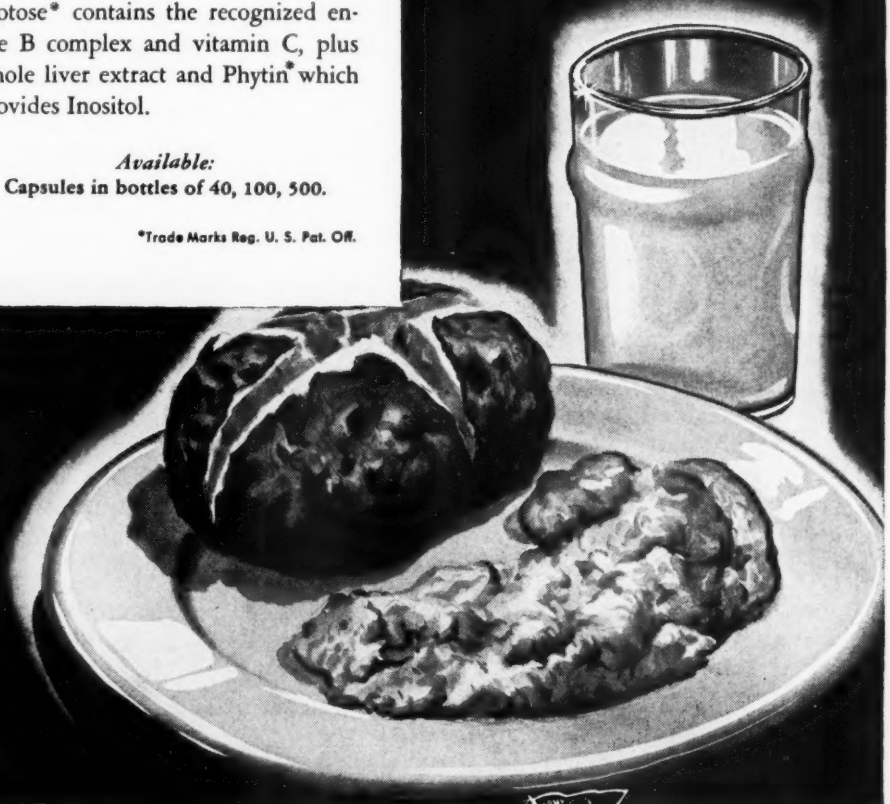

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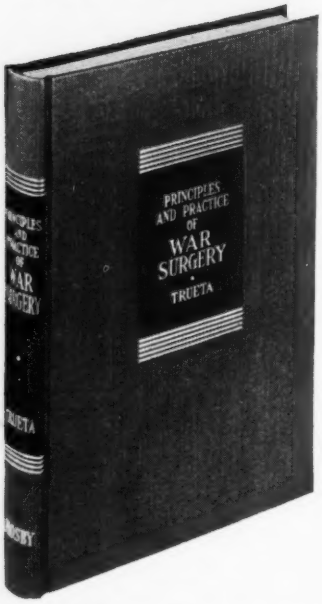

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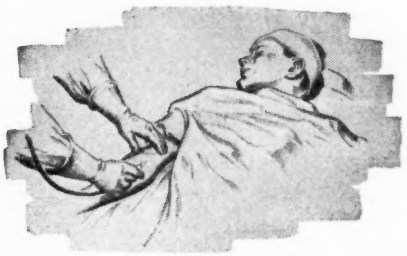

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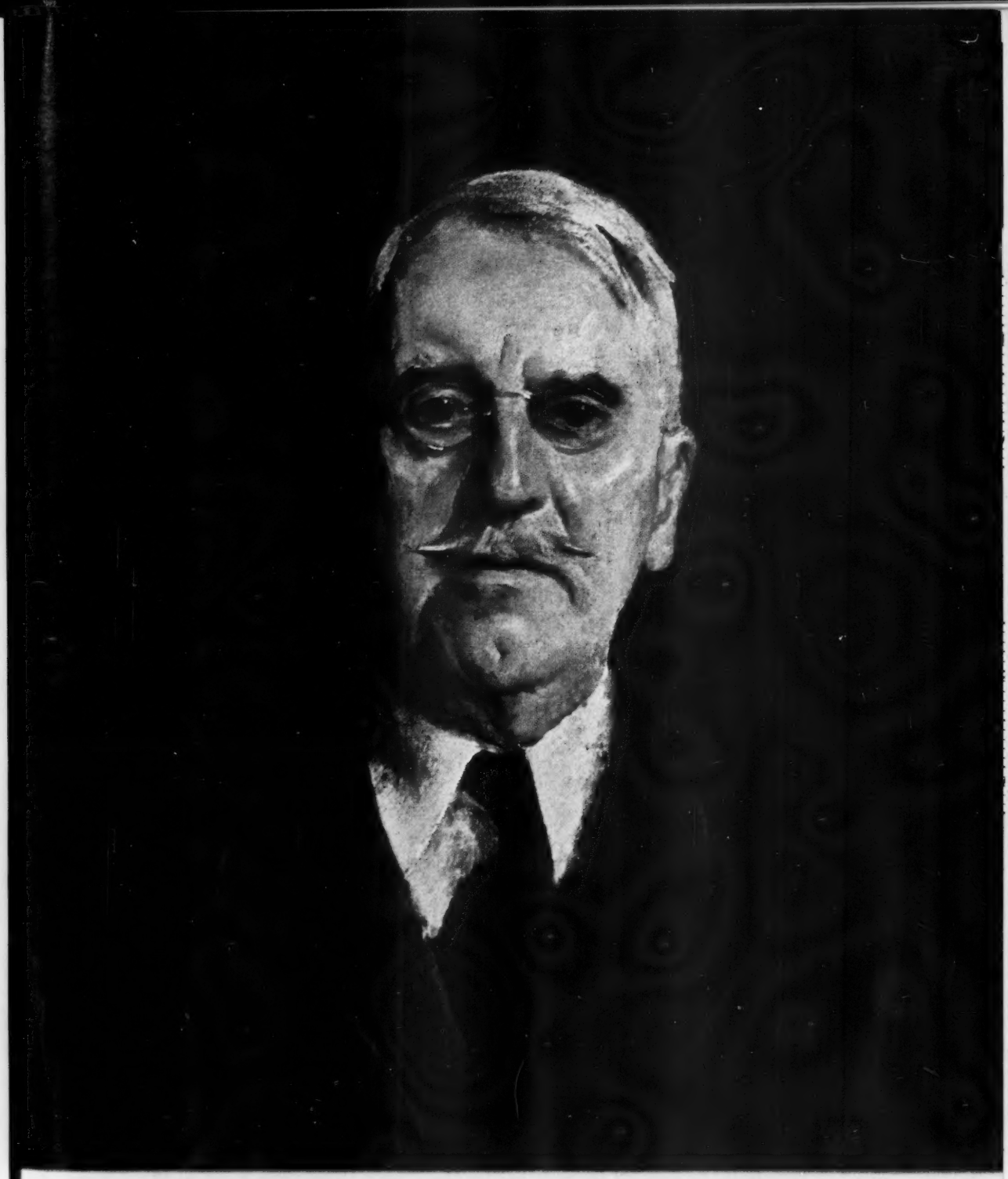

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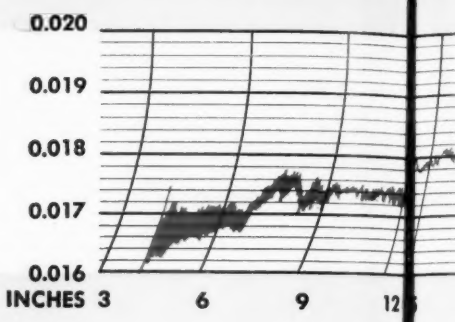

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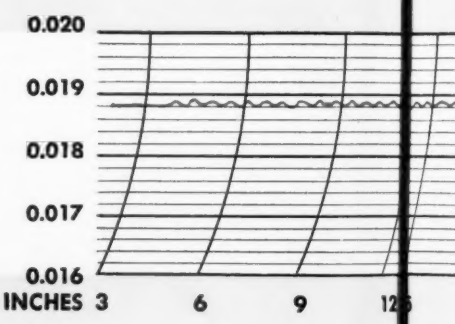

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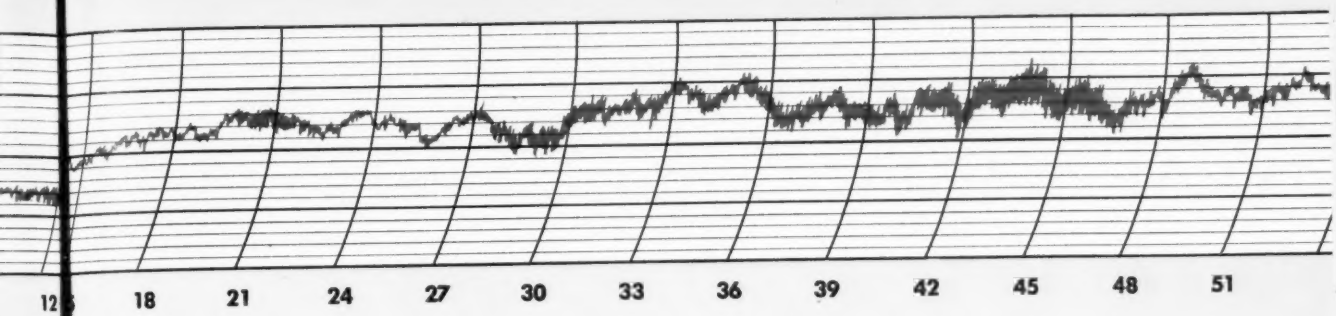

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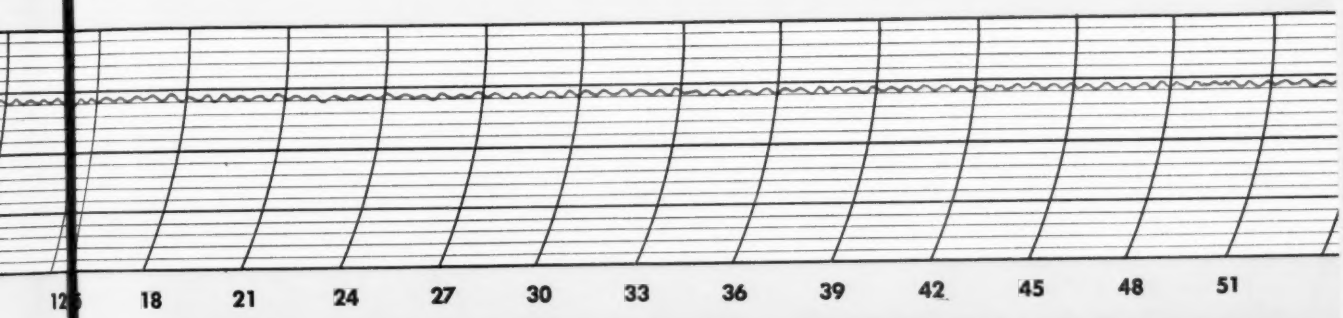

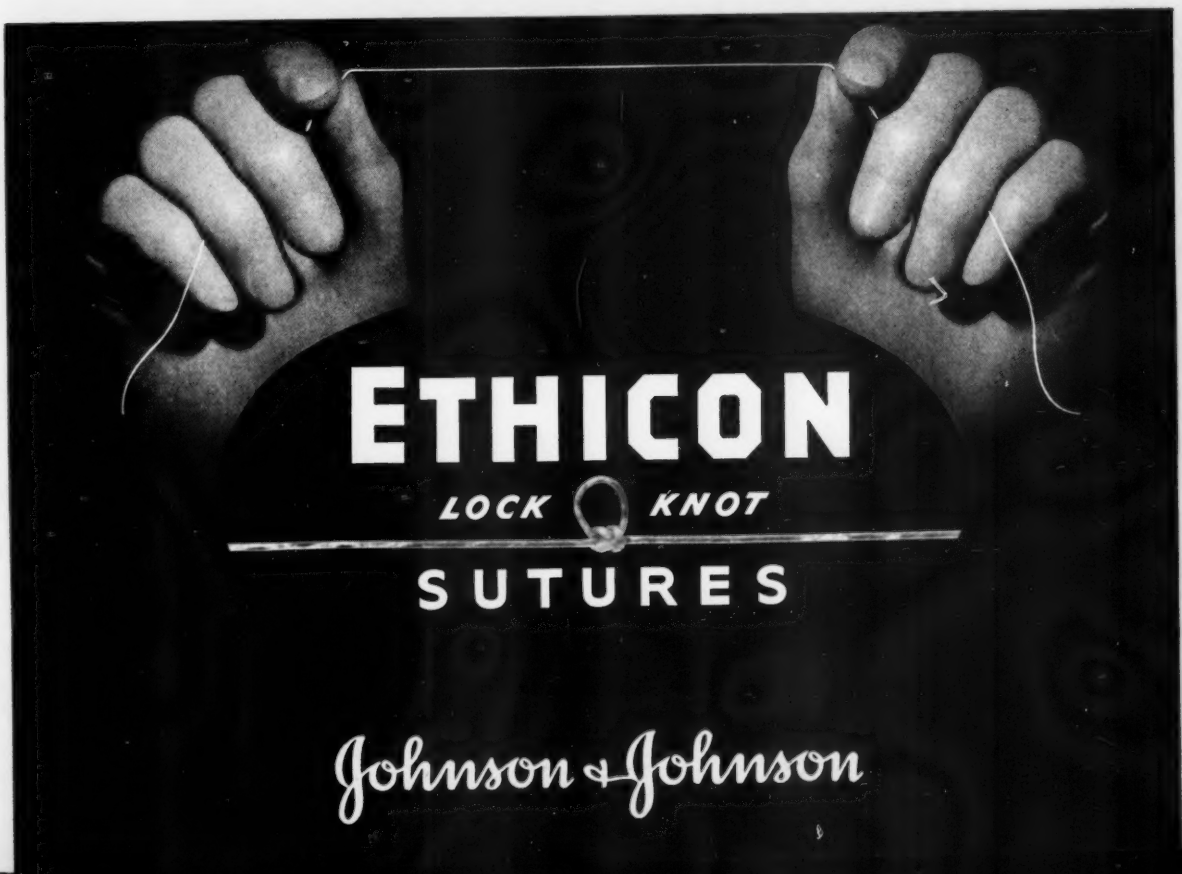

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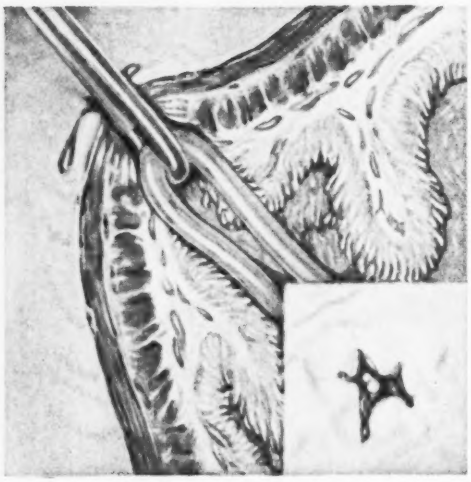

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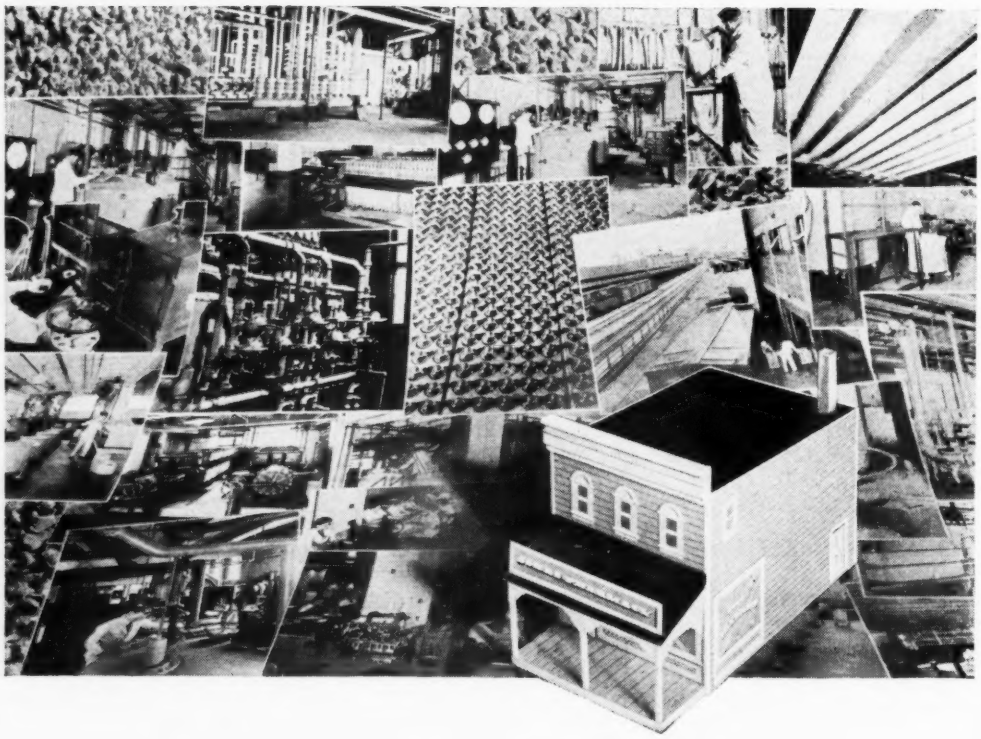

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SURGICAL CARE OF THE WOUNDED IN THE UNITED STATES ARMY*

MAJOR GENERAL NORMAN T. KIRK, SURGEON GENERAL
UNITED STATES ARMY

ALTHOUGH in this war greater obstacles are encountered in providing adequate care of the wounded, the mortality and morbidity rates among our wounded are the lowest in the history of warfare. This gratifying achievement is the result of a carefully planned and intensively applied program of medical care which extends from the front line of battle to the general hospitals here at home. It is designed to save life by instituting treatment as soon after injury as possible and to restore maximum function by applying the most effective therapeutic measures known to medical science. That this program has been eminently successful is due to a number of factors, among the most important of which are intelligent mobilization, training and organization of personnel, advancing hospital facilities as close to the line of battle as possible in order to render prompt and specialized surgical care, increasing speed of evacuation of the wounded, and application and utilization to the fullest extent of the most modern developments in medical therapy. In addition to these factors, there is still another which has contributed as much or even more to the unqualified success of this program. This factor is concerned with the functional performance of our individual medical officers whose rapid metamorphosis from civilian to rigorous military life and ready adaptability toward their new responsibilities have been executed with remarkable efficiency. I would pause here to pay tribute to their inspiring devotion to duty, their physical and moral courage, their proficient skill, and the heartening enthusiasm, determination, and ingenuity which they have displayed in attacking their varied problems.

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In order to permit a better understanding and appreciation of the problems encountered and the difficulties to be overcome in the adequate care of the wounded in this war and the plan upon which the modern scheme of medical care and evacuation has been based, it is deemed desirable to review briefly certain important considerations. It has been widely publicized that in contrast with previous wars this conflict is keynoted by a high degree of mechanization and mobility. This characterization demands thorough comprehension of the factors involved, in order to permit an adequate realization of the medico-military problems that are immediately posed in the adequate care of the wounded. Thus, during the active phase of engagements there may be a rapid progression of troops, leaving the wounded scattered over a large area, and even a constantly moving battalion-aid station will find it difficult to keep up with this advance. Many of these wounded must be sought on the battlefield where they lie after being hit and require litter transportation, the difficulties of which are further increased in regions of poor roadways and mountainous or jungled terrain. For similar reasons, their evacuation to the rear frequently requires fatiguing and time-consuming litter transportation. It becomes evident, therefore, that the first great obstacle in the administration of ideal treatment is the time elasping between the occurrence of the injury and the institution of treatment. Another important factor in this connection is the greater power of ordnance which is being used in this war. As a result of these more powerful destructive agents, a higher incidence of severe injuries must be expected with consequent increased tissue damage and resultant shock. If these patients are to be saved they must be reached quickly, treated promptly, and handled gently. Even were their immediate removal from the battlefield to a hospital far to the rear possible, their condition of impending shock would make this highly undesirable. Still other problems which deserve consideration and which are unique in this war are those involved in the care of the wounded in amphibious operations. In these hazardous operations the difficulties of reaching and transporting the wounded and in providing adequate treatment are increased tremendously and the time factor is emphasized further. It has been a well-established principle that the sooner treatment of the wounded can be instituted the more successful are the results. This principle is emphasized in the plan of medical care in the forward area. The program is designed to overcome the difficulties enumerated previously which delay treatment, and to reduce the period between injury and institution of therapy to a minimum by shortening the distance between first-aid stations and units possessing the personnel and facilities for emergency surgical treatment and by constantly increasing the speed of evacuation. That these have been highly successful in overcoming the various obstacles described and in providing prompt surgical treatment is shown by the fact that the time elapsing between occurrence of in-

jury and first-aid care has averaged less than one hour, and between injury and emergency surgery at an evacuation hospital less than ten hours.

In order to permit a better concept of how this program of medical care and evacuation of the wounded in the combat zone functions, it is considered desirable to describe the component units of forward medical service and their mission. As previously stated, the program was planned with the view of utilizing every means possible to reduce to a minimum the time elapsing between the occurrence of the injury and the institution of therapy. Accordingly, treatment of the wounded in the combat zone is divided into two stages, i.e., the primary phase of treatment and the more definitive or emergency surgical treatment.

Each stage of treatment is provided by separate units with facilities designed for these respective purposes. The primary phase of treatment consists essentially of arrest of hemorrhage, administration of sulfonamides, application of occlusive dressings and splints, and the institution of resuscitative measures necessary to make the patient transportable. These are the urgent functions of the first and second surgical echelons which are comprised of battalion-aid stations and collecting and clearing stations. The lightly wounded, whose injury is such that treatment would permit immediate return to duty, are cared for in these stations. In addition, patients with injuries requiring immediate operation in order to save life can be treated in reinforced clearing stations. Provisions for emergency surgery of this nature may be made by attaching to certain clearing stations surgical teams properly staffed and equipped to perform these procedures. All other cases requiring emergency surgery are evacuated directly to evacuation hospitals in the third echelon. It should be emphasized that in this method of furnishing early surgical care of the wounded the plan of evacuation must not be regarded as an assembly line along which the patient receives part of his treatment at each station, but rather as a conveyance line along which the patient's condition is carefully checked and procedures to save life or to render him transportable applied. This may be better illustrated by describing the procedure that is followed from the time of injury until the wounded soldier is admitted to the hospital. All soldiers are carefully instructed in the principles of first aid which, depending upon the circumstances, they may apply upon themselves or upon their injured comrades. Company-aid men who are members of the medical department and specially trained in rendering first aid, proceed immediately behind combat troops and in certain operations actually go along with fighting troops. These company-aid men seek out the injured on the battlefield and apply first aid by administering morphine to relieve pain, by placing a dressing on the wound to prevent further contamination and to control hemorrhage. Litter bearers who are also near by and who follow the company-aid men, splint fractures, remove the casualty by litter, carry, and direct the walking wounded to the first-aid station which is as close to the

line of combat as is compatible with the performance of its mission. Depending upon the circumstances, this may be a few hundred to a few thousand yards behind the line of attack. A medical officer here carefully examines the wounded soldier, appraises his condition, and determines his priority in evacuation in accordance with the type and character of the wound. Plasma may be administered to combat shock, the control of hemorrhage is assured, wound dressings and splints are checked and, if necessary, secured and adjusted, and sulfonamides administered. As soon as feasible the patient is evacuated by litter to a collecting station which is located several hundred yards behind the battalion-aid station. At the collecting stations the wounded are again inspected, bandages and splints are adjusted, tourniquets are loosened, and dressings are changed if necessary. Additional plasma is administered in cases in which the threat of shock is present. As soon as it has been determined that the patient is transportable, he is evacuated to the clearing station which is usually a few miles farther to the rear. This is usually accomplished by ambulance, but may also be done by converted jeep or truck or by litter, under certain conditions of terrain. The clearing station is equipped to give more elaborate supportive therapy, but no actual surgery is performed here unless it is urgently indicated. The casualties are critically examined and classified in the receiving department or triage.

Many slightly wounded soldiers may be fit for duty after little or no further treatment. Patients in shock or impending shock are admitted to the shock section. Patients whose splints need adjustment or whose wounds require inspection or redressing are admitted to the surgical section. Certain types of wounds such as head wounds, sucking wounds of the chest, and abdominal wounds are given priority in evacuation to the hospital, but if the injury is such that further removal to the rear without surgery would be life-endangering, immediate operation may be done by the attached surgical team, if available. All other wounded are then evacuated to the nearest hospital staffed and equipped to perform adequate surgical treatment and possessing facilities for postoperative care, which in most instances is the field or evacuation hospital. Thus, it may be observed that the wounded soldier has been provided with the therapeutic measures necessary to save life and limb and to deliver him to the hospital in a condition permitting emergency surgical treatment.

At the evacuation hospital the first phase of definitive surgery begins. A careful assessment of the patient's general condition is made and necessary preoperative supportive measures applied. Roentgenographic or fluoroscopic examination is performed and the type and extent of surgery ascertained. The surgical management of the wound is then instituted. Whereas the fundamental principles involved in the treatment of wounds are similar no matter how incurred, in war wounds some optative measures are precluded and certain modifications are

necessitated in accordance with military expediency. Thus, in civil life the wounded patient can be quickly brought to a fully equipped modern hospital and operated upon within a few hours. Under these ideal conditions where the patient can remain in the hospital until he has completely recovered and where he can be closely watched during this entire period by the same surgical team, the procedure of débridement and primary closure is admittedly the most desirable. In military practice these ideal conditions do not exist. Therapeutic procedures must frequently be done under adverse circumstances and expediency becomes an absolute necessity. Even were it possible to perform the débridement within a few hours after injury, it is rarely possible to keep the patient in the same hospital and under the constant watchfulness of the surgical team that does the operation until complete healing and recovery has occurred. The evacuation hospital has been so termed because it signifies its essential function. The patient must be evacuated to a general hospital as soon as his general condition permits transportation, otherwise the bed capacity of the evacuation hospital is soon reached and its function lost. The dangers of primary closure of the wound under these conditions are obvious and the soundness of the principle of leaving war wounds open after débridement becomes evident. Yet this principle in war surgery, which became well established in the last World War and reaffirmed in subsequent conflicts, is too often not observed by surgeons who have recently arrived in the combat zone, as well as at home. Disregard of this basic precept of war surgery almost invariably leads to disastrous consequences and is clearly illustrated by the following example: During the earlier part of a campaign in one of the overseas theaters, wounds were left open and practically no serious infections and only one case of gas bacillus infection were observed in the wounded évacués. Subsequently, the wounded from this area began to arrive with closed wounds and the incidence of gas bacillus infection rapidly rose to almost 2 per cent. Other mistakes which are commonly made by the uninitiated war surgeon are tight plugging of the wound by packs, failure to immobilize the site of injury, overexcision of the skin, failure to open deep spaces, lack of appreciation of the shattering power and extensive tissue destruction produced in war wounds, and failure to pad and to bivalve casts of the extremities.

It is, therefore, apparent that although the basic principles in the management of wounds are applicable, certain factors under war conditions deserve consideration. Every war wound must be regarded as potentially infected and its conversion into a clean wound is essential. In accomplishing this by performing débridement, emphasis is placed upon the following procedures: Because tissue damage is frequently more extensive than is apparent on the surface, adequate exposure to permit access to all parts of the wound is absolutely necessary. In doing this very little skin need be excised, but good exposure may require longitudinal incision of the skin and the fascial planes. Readily accessible

foreign bodies and especially pieces of clothing, particles of bone completely separated from the periosteum, and blood clots are removed. It is also important to excise all tissue that is soiled, devitalized, or has an impaired circulation. This is particularly true of muscle tissue. Hemostasis is effected and vaseline gauze dressings are laid loosely in the wound but not packed in. No sutures are to be used. These wounds must be left open. The part should then be immobilized by adequate splinting, even in the absence of fracture. A stimulating or "booster" dose of tetanus toxoid is routinely administered. In this connection it is noteworthy that no case of tetanus has occurred in American soldiers who have been properly immunized and have received these tetanus toxoid injections.

Although in general the surgical management of wounds of the soft parts in the evacuation hospital is essentially as described, there are certain distinctive procedures applicable to special types of regional wounds. Head wounds have comprised less than 10 per cent of all wounds. Because these patients do not withstand transportation well after operation, they are given priority (consideration) in evacuation to the hospital where adequate surgical treatment and postoperative care are feasible. Even a transport time of forty-eight or seventy-two hours does not contraindicate this policy since it has been demonstrated that operation can be delayed this long and more satisfactory results obtained in head wounds if this procedure is followed. At the hospital careful débridement of the scalp is done with every effort made to conserve as much skin as possible. In compound fractures, loose bone fragments and accessible foreign bodies are removed, and if necessary the bone defect may be enlarged, but extensive bone flaps are avoided. Evidence of an underlying clot demands opening the dura and evacuation of the clot. When the dura has been penetrated and damaged brain tissue is present, it may be removed by gentle irrigation and suction. These wounds must not be packed but should be closed around a small drain.

Maxillofacial wounds have been relatively few and have not constituted a serious problem. The important consideration in the emergency surgical treatment of these wounds is conservation of tissue in order to facilitate subsequent reconstructive procedures. Moreover, in contradistinction to the general rule of leaving war wounds open, these wounds should be closed if this can be accomplished without producing undue tension. It has been found preferable in cases with wounds opening into the buccal or nasopharyngeal cavities complicated by a compound fracture, to approximate the lacerated soft parts by bandage and adhesive strips rather than suture.

Certain types of chest wounds demand special attention. Sucking wounds of the chest require immediate closure and earlier in the war this was being done by emergency suture without adequate débridement. This frequently resulted in tension pneumothorax with consequent death

on the way or shortly after reaching the hospital. In others the wound soon became infected and broke open, thereby greatly increasing the difficulties of management. For these reasons it has been found more desirable to effect emergency closure by the application of a pad of gauze heavily coated with vaseline and folded to fit the wound. This may be held in position in large wounds by attaching it to the skin edges with a few sutures, over which a supportive gauze dressing is securely strapped. These patients are given priority in evacuation to the hospital where wound débridement and surgical closure can be properly done. Tension pneumothorax requires immediate relief by aspiration or release of air through a needle inserted into the chest. During evacuation the recurrence of tension pneumothorax must be considered and in order to obviate this it has been found best to arrange a flutter valve which can be fitted to the needle or small catheter which has been inserted into the pleural cavity. This can be made from thin rubber tissue such as that from an old rubber glove, a Penrose drain, or other items made of similar material. Novocain block of the intercostal nerves supplying the injured area has been found especially useful in controlling pain in cases of rib fractures and other chest wall injuries. Conservatism has been the keynote in the management of simple hemothorax. Simple aspiration to relieve respiratory embarrassment without air replacement has given the best results. Progressive internal bleeding is usually from the chest wall or from a large visceral or mediastinal vessel. This demands either revision of the wounds of entrance and exit or thoracotomy.

Whereas abdominal wounds comprise a relatively small number of all war wounds, they are particularly important because they contribute most to the case fatality rate. This is accounted for by the frequency and gravity of such complications as shock, hemorrhage, and peritonitis. The seriousness and early development of these complications demand emergency surgical treatment as soon after injury as possible. Moreover, these patients cannot tolerate early transportation after operation. For these reasons these patients are given priority in direct evacuation to hospitals where facilities exist for emergency surgical treatment and adequate postoperative care. Accordingly, depending upon the circumstances, they are treated by the surgical teams attached to a clearing station or at an evacuation hospital. In addition to the well-established principles that are followed in the surgical management of these cases, the procedure of exteriorization in large bowel injuries has been found particularly valuable. Indeed it may be considered as one of the important advances in military surgery in this war. The damaged segment of bowel is simply and expeditiously exteriorized by drawing it out through a separate incision, preferably in the flank. The formation of a spur greatly facilitates subsequent closure. The Levine tube and Wangensteen suction, along with sulfanilamide, have saved many lives in prevention and treatment of peritonitis.

Wounds of the extremities have always comprised the largest number of war injuries and in this war have accounted for about 65 to 70 per cent of all wounds. Obviously, from a medico-military point of view, they are the most significant type of war wounds. The preliminary surgical treatment of most of these cases is done at the evacuation hospitals and for wounds of the soft parts is essentially as described. However, nerve and blood vessel injuries and compound fractures, which are the most important complications of these wounds, deserve further consideration. The significance of nerve involvement is shown by the fact that from 12 to 15 per cent of all extremity wounds are complicated by injury to major nerve trunks. Accordingly, the possibility of this complication has been emphasized and efforts made to direct attention toward its early recognition. Primary anastomosis of severed peripheral nerves is not generally feasible but should be attempted if the nerve ends are readily accessible and can be approximated without tension. If this cannot be done, the injured nerve ends should be identified and a sling suture of fine stainless steel wire placed between them or they should be anchored with similar suture material to the surrounding tissue, in order to prevent retraction. Metal suture material is advocated here because it facilitates roentgenographic identification preceding subsequent repair. In order to minimize the irreparable degenerative changes that occur in the end plates of severed nerves, these patients are evacuated to neurosurgical centers in this country as soon as possible for operative repair and the necessarily prolonged postoperative care.

Peripheral vascular injuries, especially those involving major vessels, are also significant complications since they may lead not only to loss of limb but also to the loss of life. The vessel may be lacerated, partially or completely severed, thrombosed, or in acute spasm. In cases requiring ligation and in order to eliminate the dangers of secondary hemorrhage, thrombosis, and vasoconstrictor influences, the vessel should not be ligated in continuity but should be ligated well above and below the point of injury with excision of the damaged segment between these ligatures. A thrombosed segment should similarly be excised. Reflex vasospasm which not uncommonly accompanies these injuries should be considered. Concussion or localized segmental spasm of the artery may occur in cases in which the injury has involved tissues remote from the vessel, as well as in those in which the traumatizing agent passes near a vessel. In cases manifesting this phenomenon the limb appears cold, pale, and pulseless, although evidence of hematoma or laceration of the vessel may be lacking. Such cases respond well to débridement of the surrounding traumatized tissue, or to novocain block of the regional sympathetics. Vasodilation should be induced in all peripheral vascular injuries by sympathetic block, which may be repeated daily for several days if necessary. Extending the period of viability of ischemic tissues by refrigeration and consequent reduction of local metabolism is a re-

cent advance which, although deserving consideration, has not been developed to the point where it is practicable for forward echelons.

Bone and joint involvement in wounds of the extremities may be considered the most important of all these complications because of the protracted hospitalization and disabilities which they produce, especially if early treatment has been inadequate. The difficulties in the ideal management of these cases are greatly increased under war conditions. Moreover, the highly destructive shattering fractures, with great loss of bone substances that are commonly observed in such cases, emphasize further the problems encountered in their treatment. For these reasons efforts have been directed toward prompt and proper management along principles which under war conditions have been found to give the most satisfactory end results. The essential problem in the management of wounds of the extremities in the forward echelons is concerned principally with the most expedient and comfortable method of immobilization during evacuation. It must provide adequate fixation for ambulance or jeep transport over rough roads and at the same time assurance that the circulation of the extremity will not be jeopardized or that additional injury of the soft part will not be incurred. These desiderata are best met for fractures of the femur about the knee and both bones of the leg above the ankle by use of the Army half-ring splints with the litter bar, ankle strap, and five triangular bandages. Traction is effected by the ankle strap or hitch about the ankle with the shoe on and by skin traction with the shoe off. This method has been found the most satisfactory for evacuating patients with these fractures from the first and second echelons to the evacuation hospital or even to the general hospital. Skeletal fixation and skeletal traction in patients who are to be transported have resulted in much discomfort and in bone infection in the pin wounds. These procedures have no place in the management of these cases in the forward echelons. Following adequate débridement in the evacuation hospital, fractures of the shaft of the femur or tibia and fractures involving the hip or knee joints are evacuated to the general hospitals in the Army half-ring splint with skin or skeletal traction or in a padded plaster spica. In this connection the so-called Tobruk splint has received favorable comment and is applied as follows: by means of traction, preferably skin traction, the extremity is pulled down, a plaster splint is molded to the posterior aspect of the thigh and leg, a half-ring splint is applied, to which the traction is made fast, and the extremity and splint are wrapped by several turns of plaster. Padded posterior and lateral wire ladder splints are considered best for evacuating fractures of the ankle and foot. In transporting patients with fractures of the humerus from the more forward echelons to the evacuation hospital, the Thomas arm hinged splint with skin traction or the immobilization of the arm to the side of the chest with a sling or Velpeau bandage incorporating a padded external splint has been found satisfactory. For evacuation to a general hospital the best method consists

of use of a U-shaped molded plaster splint extending from the axilla around the elbow and up the outer surface of the arm and shoulder to the neck, supported by bandages and a sling. For fractures of the elbow and upper one-third of the forearm, immobilization is best effected by the use of a posterior wire ladder or molded plaster splint extending beyond the wrist and supported by a sling. Coaptation splints for forearm and hand should be used.

In the management of compound fractures in these forward echelons, adequate débridement is imperative and the principles described previously are followed. Whereas internal metallic fixation is at times a valuable procedure in the definitive treatment of simple fractures, its application in the emergency surgical treatment in these echelons is followed by frequent complications and failures. For these reasons the more conservative principles of careful débridement, leaving the wound open, covered with loosely placed fine mesh vaseline gauze, and followed by cast or splinting with skin traction are advocated. The importance of properly padding and completely bivalving all casts of the extremities prior to evacuation is emphasized.

Penetrating wounds of the joints are also treated by adequate débridement, removal of all loose bone fragments, irrigation of the joint cavity, and closure of the synovial membrane. The soft tissue wound down to the sutured synovial membrane is left open and covered with loosely placed gauze. Immobilization is obtained as previously described.

Because of the highly destructive and shattering injuries, particularly from land mines, that are incurred in this war, cases requiring amputation have been relatively frequent. In the performance of this procedure under war conditions there has been an unfortunate lack of familiarity with the principles involved. The most common errors of judgment have been concerned with unnecessary sacrifice of tissue and with closure of the stump resulting in osteomyelitis, gas gangrene, or other serious infections, or a stump that is too short. All emergency amputations in these echelons should be performed at the lowest level possible which permits removal of all devitalized and contaminated tissue regardless of stump length. Revision of the stump in accordance with prosthetic considerations may be subsequently performed. The open (guillotine) circular method, with severance of successive layers at the level of retraction of the preceding layers, resulting in an inverted cone rather than a square end stump, is the procedure of choice. The wound must be left open, using a vaseline dressing. Skin traction to the stump is always immediately applied following the amputation and continued until healing occurs. The flap-type open amputation may be done only in cases in which early evacuation is not contemplated and subsequent closure at the same installation is deemed possible, such as in a general hospital.

Although burns have comprised less than 2 per cent of the war wounds, because of the grave consequences they must be regarded as

constituting a serious form of injury. Recognizing the significance of burns and the controversial forms of treatment, the Army has concentrated its efforts on the prevention and treatment of this type of injury and has developed a therapeutic program which is giving increasingly better results. The principles upon which this treatment is based consist essentially of prevention and control of shock by the adequate use of plasma, relief of pain with morphine, prevention and control of infection by aseptic precautions and administration of sulfadiazine, and prevention of contractures and excessive scarring by proper splinting and early skin grafting. In the local treatment of the burned area, tannic acid and other escharotics are no longer used. Burns are now treated locally by the application of sterile petrolatum gauze and a firm pressure dressing. This method of therapy is designed to provide the greatest amount of comfort to the patient, to exclude infection in the local area, to protect the injured skin and allow as rapid recovery as possible, and to prevent swelling and loss of fluids locally. Increasing experience with this method of treatment shows that more lives are being saved and better results are being obtained than by any other method previously used.

In this description of the program of medical care and evacuation of the wounded in the forward echelons, the patient has been brought from the very front line of battle where he received the primary phase of treatment to a hospital a few miles to the rear where he received the more definitive or emergency surgical treatment. From the time of injury until his admission to the evacuation hospital, which is staffed and equipped to perform the respective forms of emergency surgical procedures that have been briefly presented, less than ten hours have elapsed. Thus, it becomes apparent that this plan for the care of the injured in the combat zone, which couples speed of evacuation with advancement of hospital facilities, permits not only application of lifesaving surgical measures, but also reduction of the serious complications and morbid consequences that would otherwise occur. It should be realized, however, that this general plan of forward medical service is not fixed but possesses sufficient flexibility to meet the demands of military strategy and varied problems of changing terrain. Under certain conditions clearing stations may be required to function as evacuation hospitals and collecting stations as clearing stations. These adaptations can be readily made by the use of mobile surgical units and the highly trained auxiliary surgical groups which are composed of specialized surgical teams including neurosurgery, maxillofacial and plastic surgery, orthopedic surgery, chest surgery, and general surgery. In jungle warfare in which transportation facilities are limited to human carriers, this purpose has been met by the use of portable surgical hospitals. In amphibious operations, hospital ships whose primary function is transportation of the wounded may be converted to perform this function. Thus, by these variable adaptations it has been possible to advance hospital facilities and to pro-

vide the prompt and highly trained surgical care of the wounded in the forward echelons under varied combat operations and adverse geographic conditions.

After the wounded have received the appropriate emergency surgical treatment indicated here, in the evacuation hospital, which is the last echelon in the combat zone, they are evacuated to the general hospitals. This is done as soon as the patient's condition makes him transportable and usually within a week after admission and treatment. Transportation is accomplished by the most readily available means. In some instances it is done by ambulance, converted jeeps or trucks, or by hospital trains. In others, hospital ships, which have proved extremely useful with their multipurpose adaptabilities, especially in amphibious and insular operations, are employed for this procedure. In still others, air-transports are used and have played an important role in the rapid evacuation of wounded from relatively inaccessible areas in which other transportation facilities are limited and travel is arduous.

The general hospitals that receive these patients are located well behind the line of combat and under relatively more stable conditions. They are comparatively large installations of 1000 beds or more possessing all the equipment and facilities for the institution of the best and most highly specialized surgical care. Many of these hospitals are comprised of affiliated units completely staffed from the ranks of medical school faculties and representing the most talented and experienced men of the profession. The extraordinary liberality and the cheerful contribution of the medical schools of this country in re-establishing these general hospitals deserve the highest commendation. The function of these general hospitals in the care of the wounded may be considered twofold; to apply further and more definitive surgical treatment which would permit the patient to return to duty within a period of a few months or, if the soldier's injury precludes his return to duty or will require prolonged hospitalization, to prepare the patient for evacuation to this country. Definitive surgery performed at these hospitals included all specialties and their high level of professional performance is demonstrated by the steadily increasing numbers of wounded that are being returned to duty. Many of these patients are sent from general hospitals to convalescent centers where they are reconditioned for combat duty. Patients whose injuries make them unfit for further military service and all those who will require further definitive treatment and more than four to six months' hospitalization are evacuated by hospital ships and transports to the general hospitals here at home as soon as they can be made transportable.

The wounded évacués arrive at ports of debarkation and are received at near-by general hospitals where an assessment of their general condition and type of injury is made and necessary supportive measures applied. The patients are then classified according to the character of the injury and sent in hospital trains to general hospitals in the interior.

The Army Medical Department now has forty-eight of these general hospitals in operation and provisions for eleven more. They are all completely equipped with the most modern facilities and staffed by highly competent physicians, representing all the specialized fields of medicine and surgery. In addition, a number of these hospitals have been designated as specialized centers for the treatment of patients with certain conditions in which a high degree of specialization is necessary. Thus, at the present there are five centers for chest surgery, five for plastic and ophthalmologic surgery, five for amputations, sixteen for neurosurgery, two for vascular surgery, and two each for the rehabilitation of the blind and the deaf. These highly specialized centers are strategically located and in so far as possible, patients are sent to the appropriate hospital nearest their home. This program of the final phases of definitive surgical care of the wounded is directed toward the physical rehabilitation as well as the psychologic reconditioning of war casualties so that the maximum number may be salvaged and permitted to resume a useful place in industry and society.

THE PLASTIC REPAIR OF SCAR CONTRACTURES

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A CONTRACTURE may be defined as a pathologic shortening that results from pull of a scar which is secondary to a cutaneous loss. By far the greater majority of contractures result from skin defects that follow improperly managed third degree burns. Likewise, if cutaneous loss after a large avulsion is not covered early with a skin graft, the scar resulting from the closure of the wound by secondary intention may contract in the same manner as that following third degree burns. Improperly sutured lacerated wounds may produce similar complications. The harmful scars which create these conditions are found chiefly around kinetic areas such as the eyelids, mouth, neck, axillae, and the extremities.

PREVENTION

The prevention of scar contractures as with any other disease, of course, is most desirable. The early covering of cutaneous defects following third degree burns with a properly selected type of skin graft is the ideal procedure. Moreover, replacement or skin grafting of avulsions should always be carried out as soon as the patient's condition will permit. Lacerated wounds should be closed with care and thought. Linear lacerations on flexor surfaces such as the fingers may tend to develop contractures after healing occurs due to the straight line scar. This often can be obviated by the construction of one or more Z flaps (Figs. 1 and 2) at the time of primary closure, thus producing a staggered instead of a straight scar. It is futile to attempt to prevent scar contractures by traction or splinting in either the early or late stages unless provision is made to eliminate the offending scar. Temporary improvement might be obtained but owing to the fact that all scar tissue tends to contract, the extended parts will promptly revert to their original malposition as soon as the traction or splinting is removed.

TREATMENT OF HEALED SCAR CONTRACTURES

The treatment of healed contractures first involves the excision of all contracting scar tissue following which the remaining parts are returned to their normal anatomic position. The cutaneous defect that results from this maneuver is always much larger than the size of the scar

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excised. One never ceases to be amazed at the size of the real dimension of the actual defect after it has been properly prepared by removal of all contracting scar tissue.

Once the cicatrix has been excised, the contracted part is extended and hemostasis controlled. The surgeon is then confronted with the problem of covering the resulting cutaneous loss. The actual method of closure for any such defect is based upon fundamental principles plus some imagination and ingenuity on the part of the operator in dealing with the particular problem at hand.

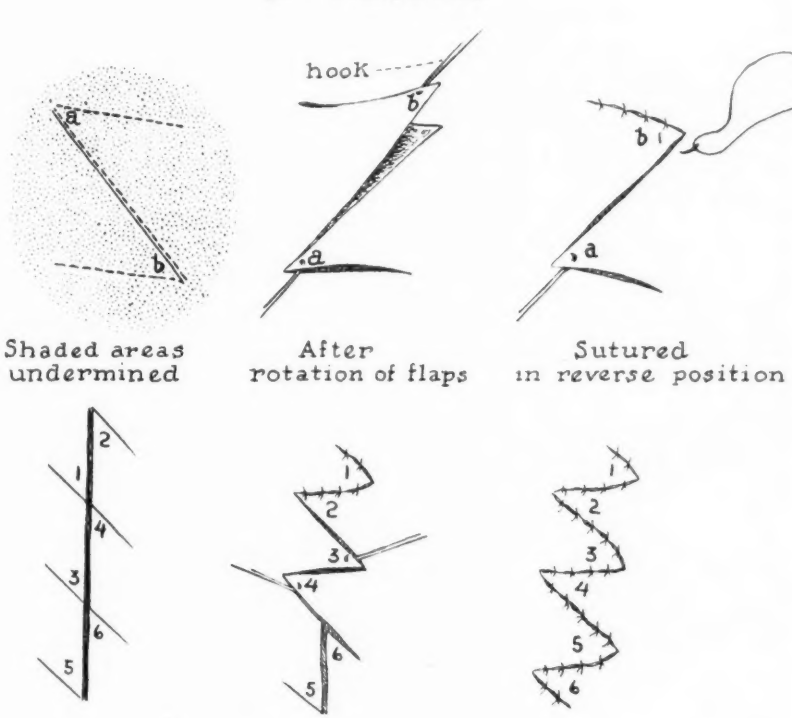


Fig. 1.

There has been considerable effort expended on the part of some plastic surgeons during recent years to close defects of this type by simpler and less cumbersome methods. Complicated pedicle flaps of skin have been supplanted to a large extent by some kind of free graft or by the use of Z plasties and interpolated flaps whenever such procedures can be utilized.

In selecting the proper type of skin graft to use one must keep in mind the comfort and safety of his patient, the economic problem involved, and the final functional and cosmetic result desired. Since the

use of pinch and Thiersch grafts give rise to much subsequent scarring, the contracture may recur. Free full-thickness skin grafts may be the most difficult to grow, but will give the best functional results, especially

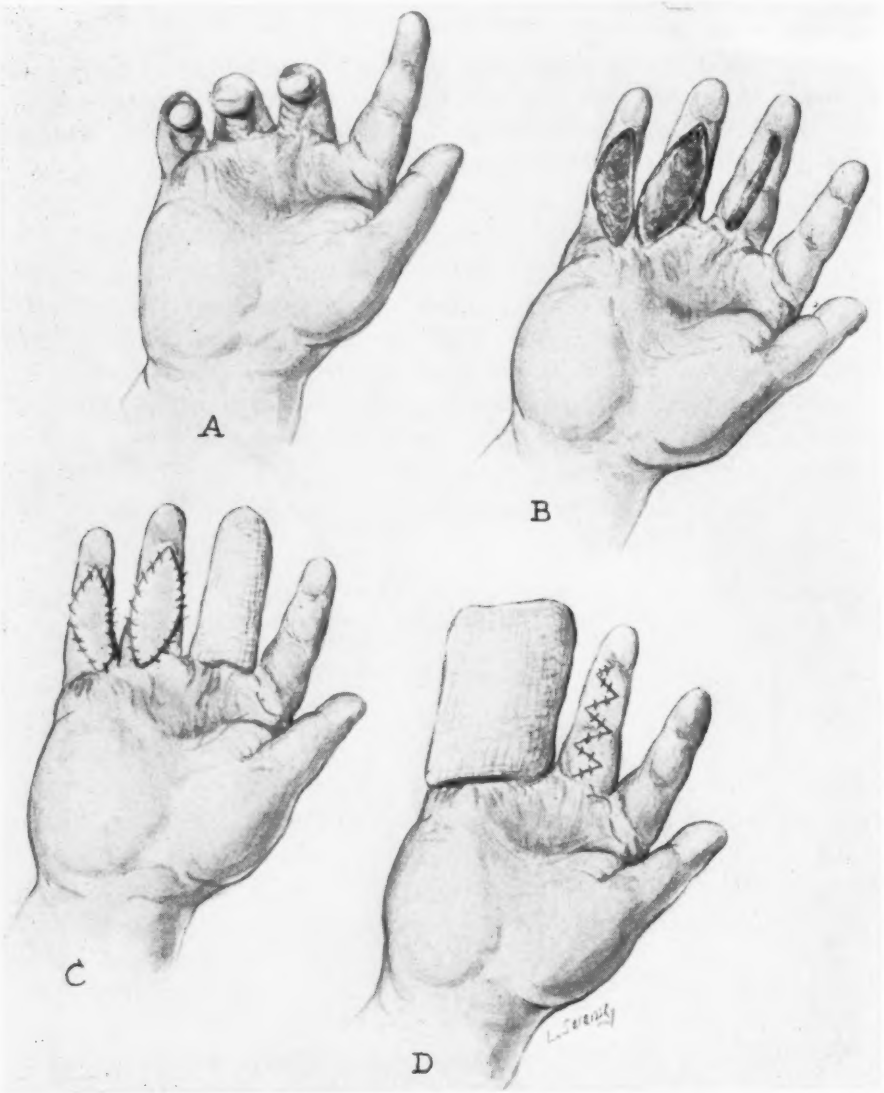


Fig. 2 (Case 9).—Drawing *A* shows scar contractures involving middle, ring, and little fingers. *B* demonstrates actual skin loss after excision of scars and extension of fingers. It is our practice in such defects to extend the incision laterally on each side producing a diamond-shaped defect. This staggers the subsequent suture line between normal skin and the graft, thereby eliminating potential recurrence of the contracture along newly created suture lines. In this case, *C* shows the ring and little fingers covered with free full thickness grafts, while *D* demonstrates how it was possible to close the smaller defect in the middle finger with a triple Z plasty.

when dealing with smaller structures such as fingers. For large defects resulting from the removal of extensive contractures of the neck, elbow, axillae, and popliteal space, we have been successful in the majority of our cases following the utilization of single massive thick split-thickness

skin grafts. These are cut in single pieces large enough to cover the defect. Being cut in these large sizes there has been a minimum amount of postoperative contraction or fibrosis. Furthermore, the donor sites heal spontaneously, the certainty of take is maximum, and the economical aspect of the patient considerably simplified.

The use of tube pedicle flaps in our experience has been reserved chiefly for those conditions needing a skin covering to which is attached a subcutaneous fat pad and for those in which such a flap could not be rotated to cover a defect from an area immediately adjacent.

We have been much impressed by the wider range of use of Z-plastic procedures as more recently popularized by Ferris Smith and Davis and Kitlowski. Many defects that have fairly mobile lateral skin flaps can be closed by this method (Fig. 1). Not only is an excellent covering available, but the area may be closed in one relatively simple procedure. By utilizing a certain amount of imagination the final scar can be so staggered that no contracture will result following complete organization of the suture line.

COMPLICATIONS

Wishful hoping will never correct a scar contracture. If these conditions are permitted to go untreated in growing children, the unyielding cicatrix will cause the formation of many underlying bony maldevelopments that may never be corrected. In addition, the functional disturbance will be accentuated, and also the cosmetic deformity will likewise be aggravated. These conditions may contribute much to the future psychologic and economic failure of the patient.

Owing to the constant pull in some cases frequently the contracting scar may break down and become the site of a chronic ulcer. Not only is this open wound a constant source of annoyance to the patient but it is a fertile field in which secondary malignant changes may develop (Fig. 14).

ILLUSTRATIVE CASES

CASE 1.—An 18-year-old girl was admitted two years after a third degree burn was sustained when she fell against a stove. The scar which developed not only produced a marked facial disfigurement but ectropion of the lower eyelid as well (Fig. 3). The scar was excised completely and the resulting defect covered with a single free full-thickness skin graft taken from the hairless inner aspect of her upper arm. A small degree of ectropion persisted after this operation. Six months later, after the first graft had softened, another small Wolfe graft taken from the upper eyelid was inserted and the remaining downward pull relieved. The missing middle third of the eyebrow was replaced by a hair-bearing free full-thickness graft from the scalp.

CASE 2.—This man received a flaplike laceration of skin a little over one inch square involving his right eyebrow and the area immediately above. He was taken

to a physician who cleansed the wound and sutured it in place following which a loose dressing was applied. Within twenty-four hours the flap became gangrenous and when referred to us was further complicated by considerable infection. At this stage it was necessary to remove the necrotic tissue and permit the wound to fill in by secondary intention. Had the original surgeon applied pressure to the avulsed flap and treated it like a piece of grafted skin, it would have undoubtedly grown in toto.

As a result of the large skin loss, an ectropion of the upper lid resulted from the pull of the forehead scar (Fig. 4). It was necessary to remove the scar and replace the defect with a free full-thickness skin graft. We next plan to construct a new eyebrow by utilizing a free hair-bearing graft from the scalp.

A. *B.*

Fig. 3.—Case 1.

Case 3.—The late results of an extensive third degree burn are well illustrated in this patient. She was first seen by us nearly two years after her injury. There is an extensive contracture of the neck and both axillae (Fig. 5).

Since the neck contracture was causing the patient the most discomfort, we first excised the contracting scar and covered the resulting defect with one large single thick split-skin graft.

At a later date, one axillary contracture was excised and replaced with a single thick split-skin graft. Two weeks later as soon as this was healed the opposite side was managed in a similar manner.

CASE 4.—As a small child this young lady suffered a third degree burn of her neck. A burn contracture resulted and was first operated upon elsewhere. The surgeon apparently excised the scar and covered the defect with Thiersch grafts. As might be expected, much fibrosis developed and when we first saw her, a great deal of deformity still remained (Fig. 6).

Upon examination it was noted that most of the subcutaneous fat had been destroyed. In fact, the larynx was uncomfortably embedded in the scar. In view of these findings, we elected to cover the anterior portion of the neck with a pedicle flap containing a good subcutaneous fat pad. This was done by turning a tube pedicle graft forward from the upper portion of the back. While a good functional result has been obtained, we must admit that it is not cosmetically ideal.

A. *B.*

Fig. 4.—Case 2.

CASE 5.—A five-year-old child had a linear scar contracture of the neck that was pulling down the corner of the mandible and mouth (Fig. 7). We excised this scar, constructed two large Z flaps, and reversed the line of pull with a very good result. This was accomplished in one operation with but five days' hospitalization.

CASE 6.—This 16-year-old girl had a broad scar on her neck that resulted from a third degree burn in childhood. It did not produce as much contraction as it did cosmetic deformity (Fig. 8). We managed this by the method of multiple excision. In two larger operations, four months apart, the bulk of the scar was excised and the wound closed by suture after wide undermining. At a third minor operation we revised the suture line. There is now but one small linear scar on the side of the neck that is cosmetically quite inconspicuous.

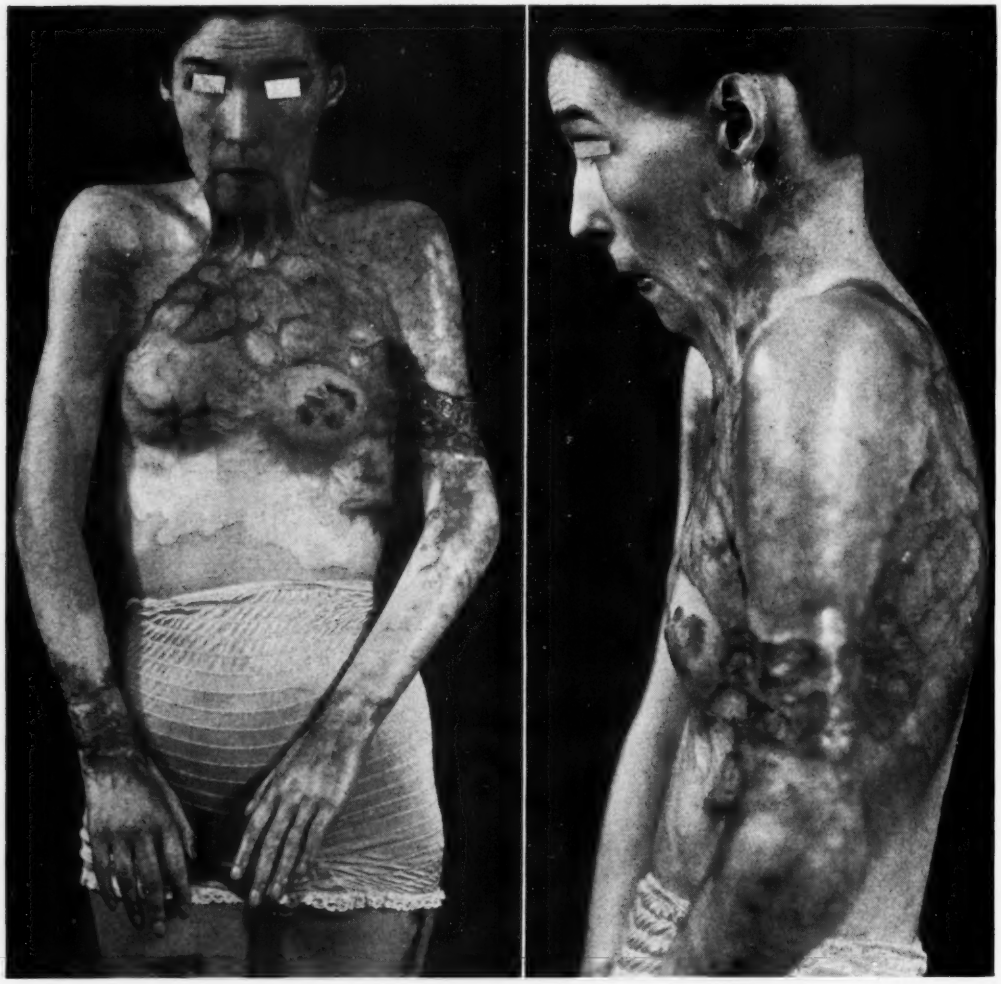


Fig. 5A.—Case 3, preoperative views of patient.

CASE 7.—The 5-year-old girl presented here had an extensive axillary contracture following a third degree burn at the age of two (Fig. 9). In one operation, we removed the contracting scar, abducted the shoulder, and covered the resulting cutaneous defect with one single thick split-skin graft.

CASE 8.—The patient illustrated here (Fig. 10) presents a slightly different variety of axillary contracture than demonstrated in the foregoing cases. It will be noted that there is a broad web of skin that stretches across the anterior axillary

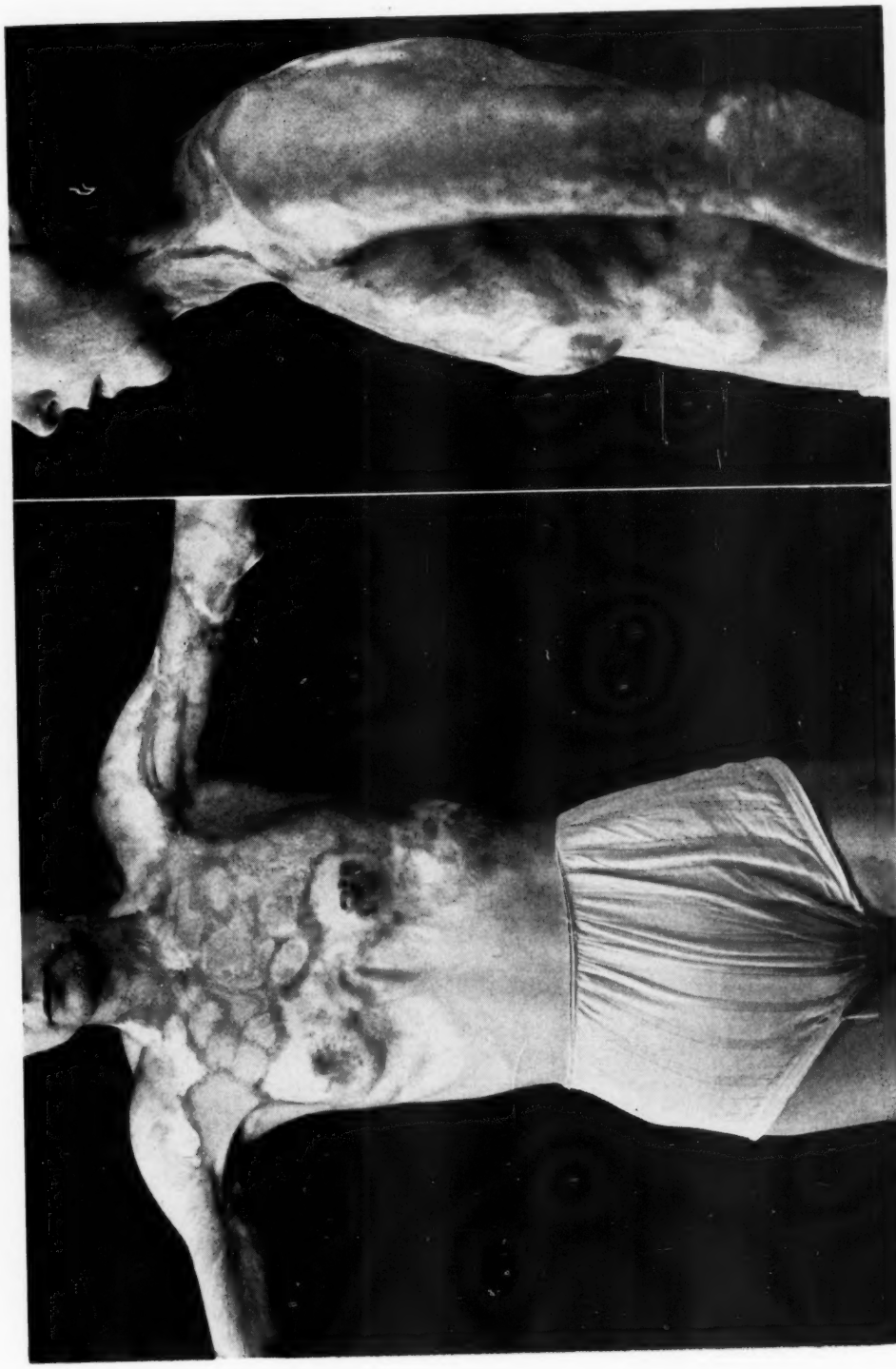
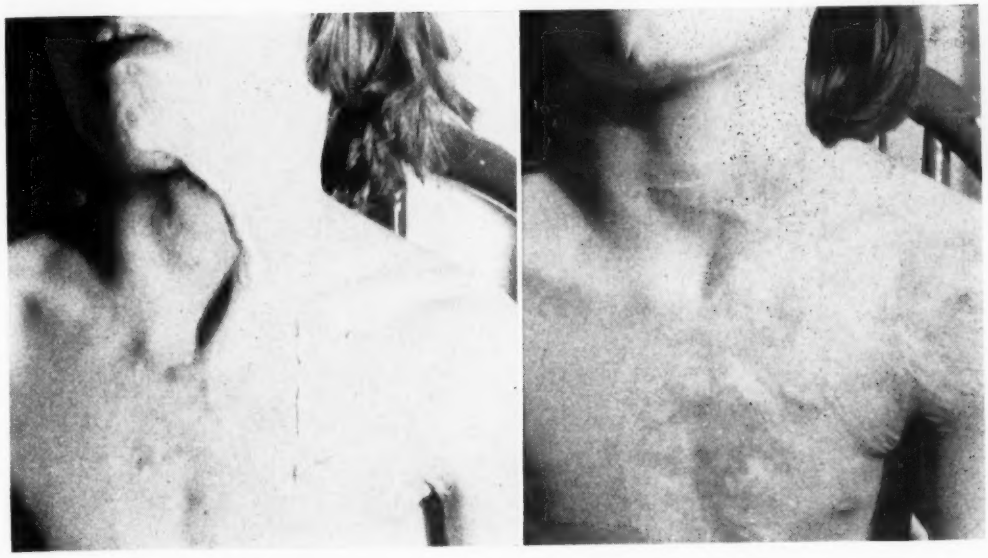


Fig. 5*B*.—Case 3.

Fig. 6.—Case 4.



A. *B.*

Fig. 7.—Case 5.

Fig. 8*A*.—Case 6.

Fig. 8*B*.—Case 6.

A. Fig. 9.—Case 7. *B.*

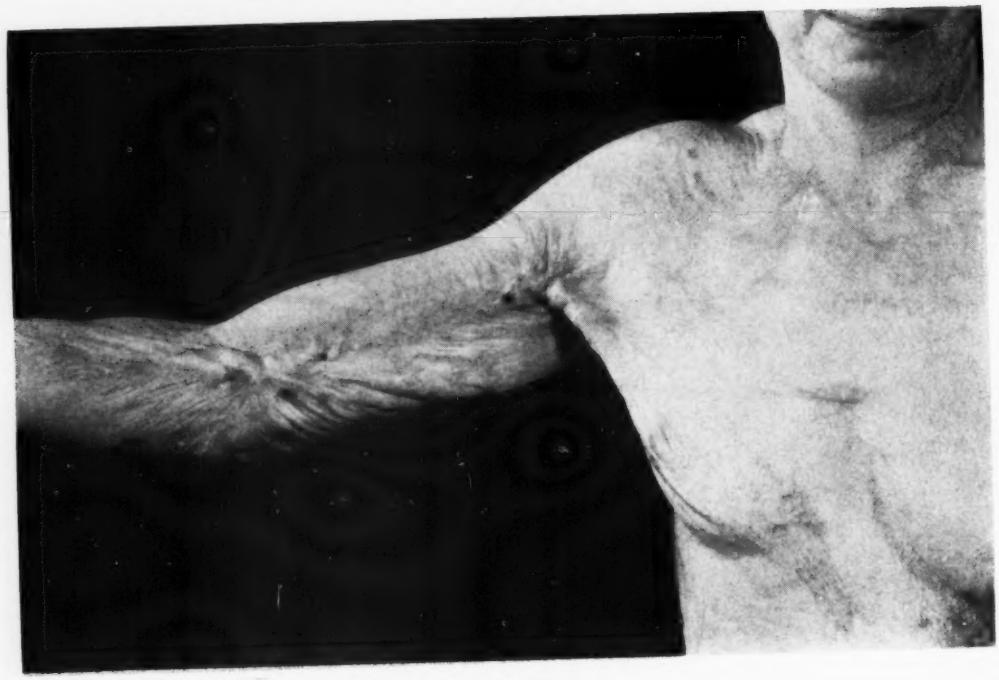


Fig. 10*A*.—Case 8.

fold. This made available two large flaps of skin so that the contracture could be relieved by a Z plasty. At the same operation the elbow contracture was excised and a single large thick split-skin graft applied. All of these procedures necessitated only nine days' hospitalization. (This is a recent case.)

Fig. 10*B*.—Case 8.

CASE 9.—A 4-year-old girl suffered third degree burns of the middle, ring, and little fingers three years before treatment. Two years previously the contracting scars were excised elsewhere, following which the wounds were simply sutured lengthwise. As soon as the scars healed, they promptly contracted back to their original deformity (Fig. 2), in spite of prolonged postoperative splinting in extension.

We re-excised the scars and replaced the defects of the ring and small fingers with free full-thickness skin grafts so that the maximum degree of elasticity of the

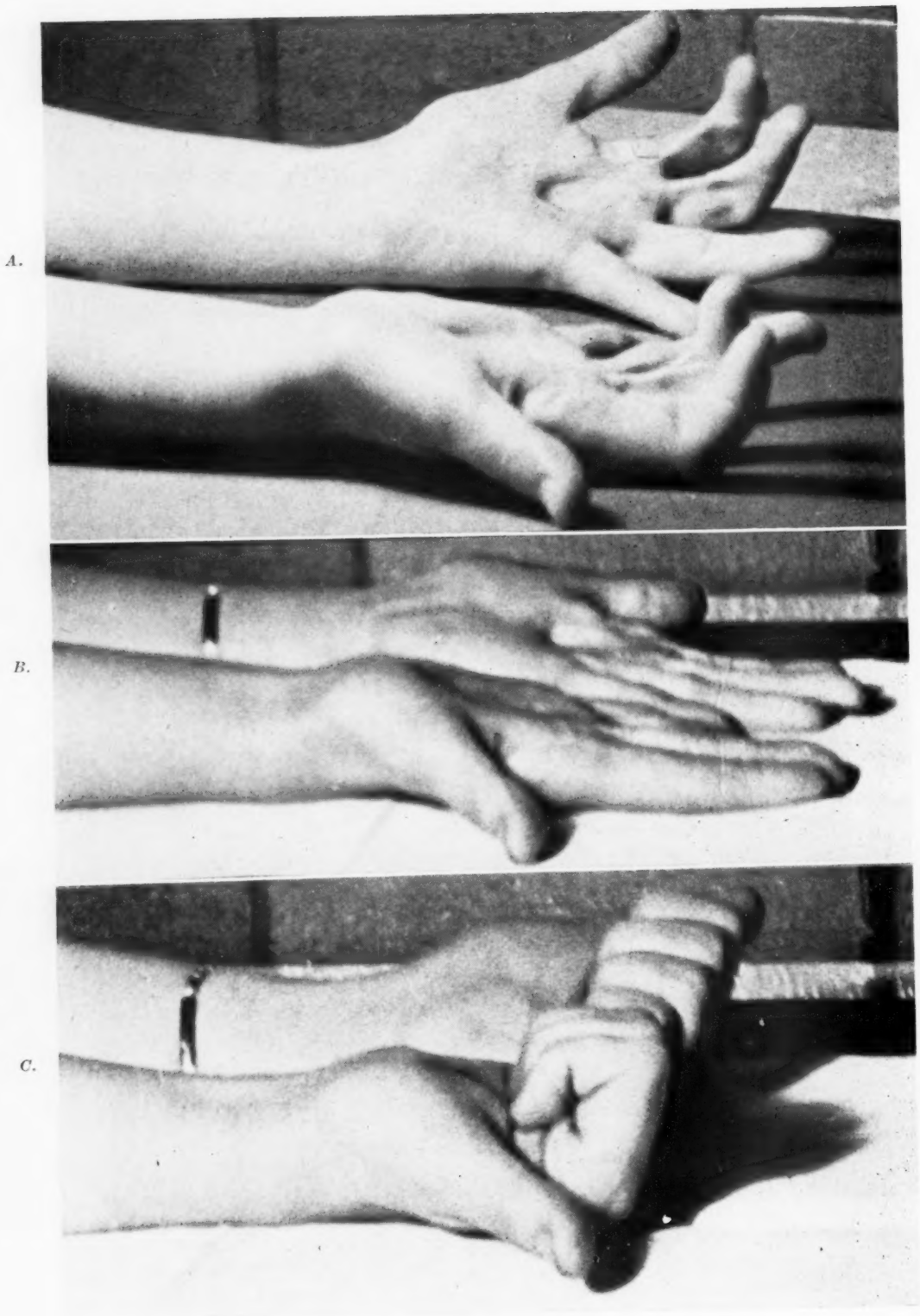
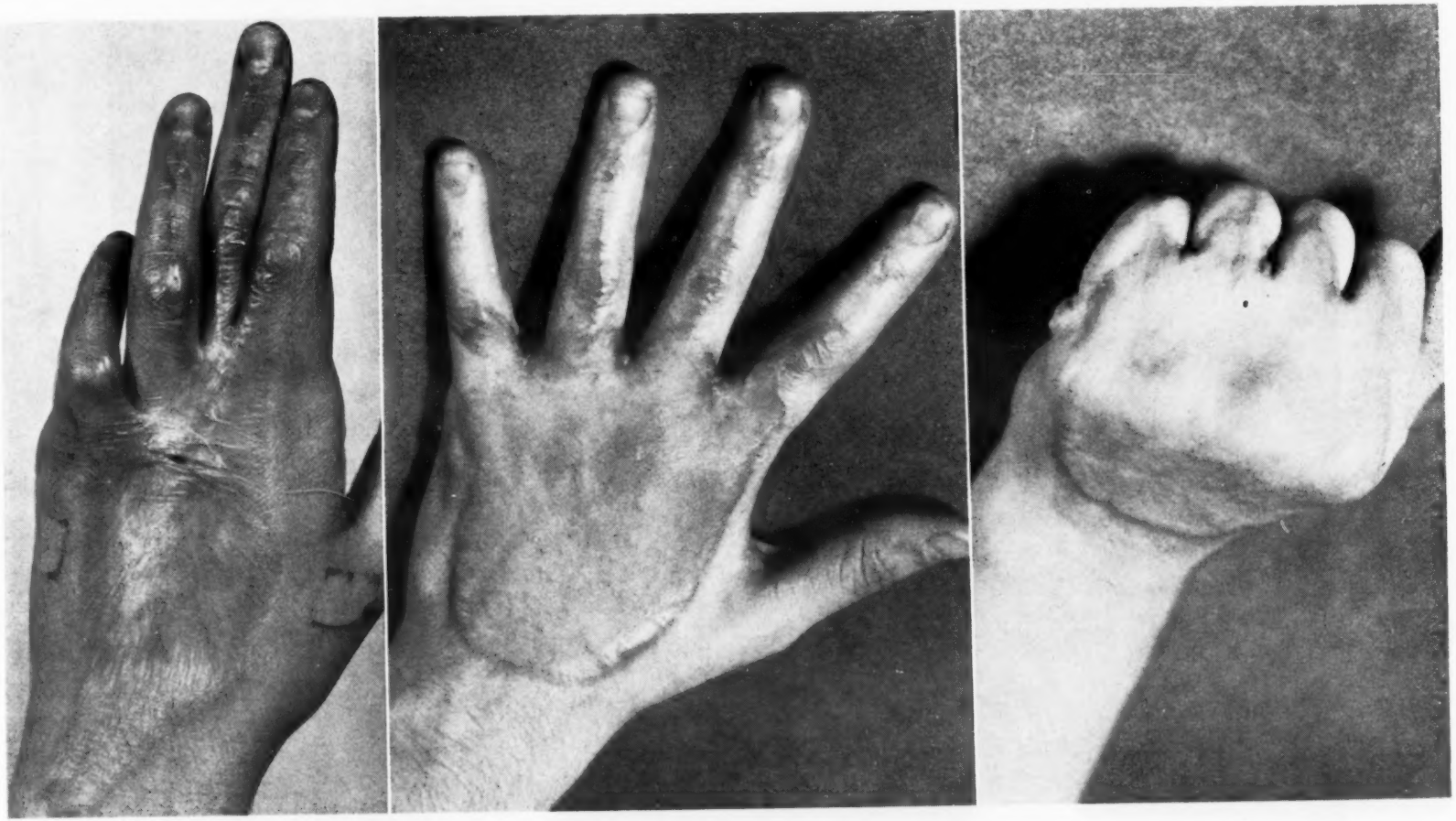


Fig. 11.—Case 10.



A. *B.* *C.*

Fig. 12.—Case 11.

B.

A.

Fig. 13.—Case 12.

covering might be anticipated. The defect of the middle finger was not as broad, thus permitting closure by the construction of a triple Z plasty.

CASE 10.—This 12-year-old girl has bilateral scar contractures of the index and middle fingers which followed a rope burn three years before. One surgeon had already excised the scars and sutured the wounds before she was first admitted to our service. The contractures which recurred (Fig. 11) demonstrate the futility of this procedure. We re-excised the contracting scars and replaced the defects with free full-thickness skin grafts taken from the anterior abdominal wall. The second hand was corrected after the first was well healed so as to make the patient's post-operative situation less awkward.

A. *B.*

Fig. 14.—Case 13.

CASE 11.—This 20-year-old girl suffered third degree burns from a steam press that involved the entire dorsum of her left hand and extended down over the extensor surfaces of the four fingers as deep second degree burns. Her surgeon dressed the open wounds with burn ointments until all the defects were covered with scar epithelium. While the covering of the extensor surfaces of the fingers was somewhat stiff, moderate elasticity developed from regeneration of the deeper derma. In contrast, however, the scar on the dorsum of the hand continued to contract until

an extension contracture developed within six months after the original injury (Fig. 12).

We corrected this deformity by first excising the contracting scar over the dorsum of the hand and extending distally over the bases of the extensor surfaces of the fingers. The cutaneous defect that followed was covered with one single thick split-skin graft. At a later date the interdigital webs were split and deepened by Z plastic procedures.

CASE 12.—Here we have a 26-year-old man who developed a contracting scar following a third degree burn during childhood that completely encircled his leg just below the knee (Fig. 13). The scar would frequently break down and ulcerate. The contraction not only caused limitation of his knee joint but also considerable swelling of the leg below.

We completely relieved the condition by excising the scar thoroughly and permitting the adjacent soft parts to retract back to their normal positions. One single thick split-skin graft was then applied so as to completely encircle the leg.

CASE 13.—Much has been said regarding the late malignant complications that develop in untreated burn ulcers but few cases are actually seen reported in the literature.

Here (Fig. 14) we have a 70-year-old man who had suffered an extensive third degree burn of his thigh and groin fifty years previously. After one year the area had filled in with a thick fibrotic scar that would break down frequently and ulcerate. Three years before admission to our service a tumor developed in the area of ulceration which, when we first saw it, was gangrenous, infected, and very foul smelling.

We first excised the lesion widely, using the diathermy cutting current. After clean granulations had developed in three weeks, we covered the defect with two large thick split-skin grafts. We probably erred in not excising the inguinal and femoral lymph glands at the first operation since eighteen months later he had a small local recurrence in the groin. We reoperated, excising all glands, and after more granulations had formed, the defect was covered with another smaller thick split-skin graft. The leg remains healed at this time, two years after the first operation. Sections showed the tumor to be an epidermoid carcinoma.

Note: The chronic recurring ulcer in Case 12 is the logical forerunner of a later malignant degeneration.

CONCLUSIONS

1. Scar contractures can be relieved by first excising all shortened fibrotic tissue, following which the parts are extended into normal anatomic position. The resulting cutaneous defects are then closed by the use of a Z-plastic procedure or the utilization of a properly selected type of skin graft.

2. Scar contractures may be prevented by the early skin covering of granulating defects resulting from burns or avulsions of skin. Careful planning in the suture of lacerations may likewise avoid the development of contractures if the line is closed in a staggered axis.

3. All contractures in growing children should be corrected before permanent underlying bony maldevelopments occur. Moreover, chronic ulcerations occurring in certain contractures should be repaired promptly for fear of secondary malignant changes.

REFERENCES

1. Smith, Ferris: J. A. M. A. **120**: 5, 352, 1942.
2. Davis, J. S., and Kitlowski, E. A.: Ann. Surg. **109**: 1001, 1939.
3. Morestin, H., Bull. et mém. Soc. de chir. de Par. **41**: 1233, 1915.
4. Mac Collum, Donald W.: J. A. M. A. **116**: 2371, 1941.
5. Mac Collum, Donald W.: Am. J. Surg. **39**: No. 2, 275, 1938.
6. Kazanjian, V. H.: New England J. Med. **215**: 24, 1104, 1936.
7. Coughlin, W. T.: Surg., Gynec. & Obst. **68**: 352, 1939.
8. Greeley, Paul W.: Illinois M. J. **75**: 436-441, 1939.
9. Greeley, Paul W.: S. Clin. North America **22**: 1, 253, 1942.
10. Young, Forrest: Surg., Gynec. & Obst. **67**: 73, 1938.
11. Gillies, H. D.: Am. J. Surg. **43**: No. 2, 201, 1939.

EPITHELIZATION AS AFFECTED BY NICKEL PECTINATE AND OTHER AGENTS

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INTRODUCTION

THE evolution of the pectin and nickel pectinate treatment for dysentery and infant diarrhea is described by Block and associates.[1] Haynes and co-workers[2] and Arnold[3] discovered that pectin alone actually stimulated bacterial growth, but that the pectinates of certain metals, nickel included, was slowly bactericidal. Myers and Rouse[4] pointed out that ionized nickel is toxic to bacteria and in addition that the catalyst, nickel, may stimulate the body's antitoxin and agglutinin production. Other qualities of nickel pectinate doubtless contribute to its effectiveness as a vulnerary. The huge pectin molecule may, theoretically at least, envelope and starve bacteria.[5] Pectin is a hygroscopic colloid, able to absorb many times its weight,[6] thus stimulating the "osmotic drainage" effect and reversal of lymph flow claimed by Smith[7] and others for glycerin. Lastly, upon hydrolysis, pectin liberates galacturonic acid, an isomer of glycuronic acid that the liver synthesizes as a chemical detoxifying agent.[4]

Thomson,[5] in 1938, reported favorable results in the use of aqueous solutions of pectin in treating burn granulations, chronic osteomyelitis, and infected wounds in general.

Since latter 1938, we have treated a variety of wounds with a preparation of nickel pectinate* containing 3 per cent pectin and 0.045 per cent nickel, either in aqueous solution or in tragacanth jelly. Merthiolate, 1:5000, was added to inhibit growth of fungi. In the great majority of cases the tragacanth vehicle was used since the thick jelly required but one application a day, an important factor in this understaffed hospital. After the toilette of the wound, the jelly was applied to a depth of 3 to 5 mm., with a sterile throat stick. From here, technique varied. Over some wounds, especially if drainage were profuse, the outer dressing consisted merely of several layers of sterile gauze and an outer pad of cellucotton held in place by adhesive or bandage. In other cases, a layer of perforated cellophane was interposed between the agent and the outer dressings in order to retain moisture. In a few extensive burns with pin-point grafts in place, a generous buttering of the nickel pectinate

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*This has been supplied to us by Eli Lilly and Company under the name of "Nipectin."

was left without any outer dressings. Especial care was taken in removal of dressings, as the pectin jelly was prone to become tightly adherent to the wound surface. In such cases, removal was usually accomplished by soaking or by pouring on hydrogen peroxide.

During the past 4 years, 65 wounds in 61 patients have been treated with nickel pectinate. As a control in this same period, comparable wounds or comparable portions of the larger wounds were dressed with cod liver oil or cod liver oil ointment. In rare instances the control agent was Dakin's solution, Foille,* sulfonamide ointment, or scarlet red. Also, similar bilateral wounds were likewise treated in 6 rabbits. I followed and supervised the course in all these cases.

CLINICAL APPLICATIONS

The Use of Nickel Pectinate in Sluggish Wounds That Have Responded Poorly or not at all to Other Agents.—Seven stubborn cases are presented in brief. In 4 cases (Patients 1, 2, 6, and 7 below), pectin seemed definitely superior to the alternate agents; in 2 cases (Patients 3 and 5), it seemed about equally effective; and in one case (Patient 4 with the ventral hernia with superficial erosions), all agents, pectin included, failed to close the erosions.

1. PATIENT N. M.—Lesion: Infected Thiersch graft donor site of left thigh. The lower left leg was completely decorticated down to the muscles as a result of extensive incisions for gas gangrene some time before. For 106 days the shallow ulcerations on the thigh were unsuccessfully treated with saline packs, Dakin's packs, gentian violet, ammoniated mercury ointment, and ultraviolet irradiations. There were still two granulating areas 2 by 3 cm. and several pustules 0.5 cm. in diameter. Culture: *Staphylococcus aureus.* Healing occurred after 60 days of nickel pectin dressings.

2. PATIENT J. K.—Lesion: Fire burn of neck and upper chest resolving into two granulating wounds each about 2½ cm. in diameter, one over each sternoclavicular articulation. Culture: *Staph. aureus.* By the fortieth day, progress on foille dressings was at a standstill and nickel pectinate jelly was started. At this time the lesions were approximately 2½ by 2 cm. and 1½ by ½ cm. in area, respectively. Healing was complete in 20 days.

3. PATIENT R. H.—Lesion: Granulating scalp avulsion wound. After pin-point grafting and 65 days of cod liver oil dressings, several nonepithelized areas remained, the largest 2 by 2 cm. Culture: *Bacillus pyocyaneus.* Nickel pectinate dressings were started and at first healing was rapid. Final healing, however, required 55 days.

4. PATIENT L. W.—Lesion: Shallow erosions, 1 to 2 cm. in diameter on the convexity of a huge ventral hernia. After 155 days of treatment with elastoplast, cod liver oil, and other remedies, there was no sign of healing. Culture: *Staph. aureus.* However, although definitely smaller, there was no healing after 40 days of nickel pectin therapy.

5. PATIENT B. A.—Lesion: Granulating pinch-grafted burn of left axilla 6.5 by 2.5 cm. in area. The lesion was slowly enlarging after 55 days of cod liver oil

*"Foille" is a proprietory water-in-oil emulsion for the treatment of burns.

TABLE I

ANALYSIS OF 18 SUPERFICIAL GRANULATING WOUNDS TREATED IN COMPARABLE HALVES WITH NICKEL PECTINATE AND WITH CONTROL AGENTS

PATIENT	AGE (YR.)	LESION	AGENTS	REMARKS	DAYS UNTIL HEALED
L. S. (See Fig. 1)	23	Granulating postburn wound of entire right upper arm, external aspect. Pinch grafted 8 days before with 90% take throughout. Culture both halves: *Strep. hemolyticus, Staph. aureus*	N.P.* upper half Foille lower half	Neither area had the advantage toward healing. The N.P. area healed in 31 days, then broke down for 41 days. This was added to its total healing time	N.P., 72 Foille, 97
D. P.	35	Superficial granulating excision site of neurofibrosarcoma of epigastrium 13 by 10 cm. Pinch grafted 9 days before. Culture: *Strep. hemolyticus,* later, *Staph. aureus*	N.P. right half C.L.O.† left half	Neither side had the advantage toward healing; granulations markedly lower on N.P. side than on control side	N.P., 23 C.L.O., 41
L. G.	12	Granulating postburn wound of back of lower thigh and popliteal area 15 by 11½ cm. in area. Pinch grafted 12 days before. Culture: *Strep. hemolyticus, Staph. aureus*	N.P. upper half C.L.O. lower half	There were slightly fewer grafts on pectin area and this area also included the flexure crease	N.P., 26 C.L.O., 26
V. M.	18	Granulating postburn wounds similarly involving backs of both thighs and calves. Pinch grafted 78 days before; slow healing. Culture: both sides, nonhemolytic strep., *Staph. aureus*	N.P. right side Foille left side	Neither side had the advantage toward healing. N.P. side had already been on C.L.O. dressings without success 78 days	N.P., 39 Foille, 55
D. B.	5	Granulating postburn wound of back of thigh, calf, and popliteal area, 15½ by 7 cm. Pinch grafted 15 days before with 75% take. Culture: *Staph. aureus*	N.P. proximal half C.L.O. distal half	Neither side had the advantage toward healing. There was marked granulation tissue hyperplasia on C.L.O. side; healing delayed both sides by intercurrent *hemolytic strep.*	N.P., 41 C.L.O., 45
S. L. (See Fig. 2)	63	Postmastectomy granulating wound 26 by 7 cm. Pinch grafted 5 days before. Culture: *Staph. aureus, B. proteus*	N.P. lateral half C.L.O. medial half	Although there was more tension on the N.P.-dressed end, overlying the axillary fold, it was slightly narrower and had an extra pinch graft or two	N.P., 23 C.L.O., 37+
B. M.	7	Granulating postburn wounds of lower back and thighs, 2 in each area measuring 8 by 3 cm. approximately. Pinch grafted 7 days before. Culture: *Strep. hemolyticus, Staph. aureus*	N.P. areas on back C.L.O. areas on thighs	Neither side had the advantage toward healing	N.P., 47 C.L.O., 65
I. R.	38	Granulating postburn wound of most of right lower leg. Pinch grafted 7 days before. Culture: *Strep. hemolyticus, Staph. aureus*	N.P. medial half C.L.O. lateral half	The C.L.O.-dressed area had a slight advantage toward healing and these dressings were less painful	N.P., 27 C.L.O., 15
A. P.	66	Two granulating varicose ulcers of leg, one 9 by 5 cm., the other 9 by 3 cm. Both pinch grafted 4 days before. Culture: N.P. side, *B. pyocyaneus,* C.L.O. side, *B. pyocyaneus, B. proteus, Staph. aureus*	N.P. on area 9 by 5 cm. C.L.O. on area 9 by 3 cm.	Neither side had the advantage toward healing; strikingly less granulation tissue hyperplasia on N.P. side	N.P., 26 C.L.O., 47

*N.P.—nickel pectinate.
†C.L.O.—cod liver oil.

B. R.	64	Long granulating, superficial postincision and drainage wound of forearm, 33 by 5 cm. Pinch grafted 11 days before with 90% take. Culture: *Staph. aureus*	N.P. distal half C.L.O. proximal half	N.P. area had slight advantage toward healing, being narrower with slightly more grafts; rate of healing much faster	N.P., 7 C.L.O., 14
S. L.	58	Granulating postburn wound of left thigh and buttock. Pinch grafted 22 days before with 65% take. Culture: N.P. side, *Staph. aureus* and *B. Proteus*, C.L.O. side same and *B. pyocyaneus*	N.P. on buttock C.L.O. on thigh	Slightly fewer grafts per unit area on N.P.-dressed area	N.P. 38 C.L.O., 43
A. G.	16	Granulating postburn wounds of both ears involving rims of auricles, each measuring 30 by 3 mm. No grafts. Culture: *Staph. aureus*	N.P. right ear Sulfadiazine ointment left ear	The two areas nearly identical; healing was delayed on N.P.-side by trauma of removing tightly adhering dressing	N.P., 16 Sulfa., 13
N. B.	3	Granulating postburn wounds back and right upper arm, former 9½ by 4 cm., latter 5½ by 4½ cm. Pinch grafted 7 days before. Culture: *Staph. aureus*	N.P. on back C.L.O. on arm	There were a few more grafts on the C.L.O. area; granulation tissue hypertrophy only on C.L.O. area.	N.P., 53 C.L.O., 65
N. B.	3	Granulating site of superficial tissue slough, right lower leg 10 by 4 cm. Pinch grafted 13 days before with poor take. Culture: *Staph. aureus*	N.P. proximal half C.L.O. distal half	Neither side had the advantage toward healing; progress slow; granulation tissue hyperplasia both sides	N.P., 63 C.L.O., 58
W. S.	39	Identical granulating postburn wounds on inside of right and left thighs; right 14 by 13 cm., left 15 by 6 cm. Pinch grafted 9 days before with 95% take. Culture: both sides, *Staph. aureus*	N.P. right side Foille left side	Neither side had the advantage toward healing; due to granulation tissue stimulation foille was changed to C.L.O.	N.P., 15 C.L.O., 15
H. R.	13	Granulating, full thickness by skin donor site of chest and upper abdomen 16 by 13 cm. Pinch grafted 5 days before with 90% take. Culture: *Staph. aureus.*	N.P. lower half C.L.O. upper half	Neither side had the advantage toward healing. Progress was more rapid with N.P.; patient away from observation at final healing	N.P., 28 C.L.O., 28
W. D.	30	Granulating postburn wound of lower back, 13 by 7 cm. Pinch grafted 6 days before with good take. Culture: N.P. side, *Staph. aureus, B. pyocyaneus.* C.L.O. side, *Staph. aureus*	N.P. right side C.L.O. and sulfadiazine on left side	Neither side had the advantage toward healing; granulation tissue hyperplasia only on control side; sulfadiazine replaced	N.P., 63 Sulfa., 80+
G. T. (See Fig. 3)	13	Granulating postburn wound of entire chest, bilaterally identical. Pinch grafted 7 days before with 60% take. Culture: *Staph. aureus, pyocyaneus, B. proteus*	N.P. left side C.L.O. right side	Neither side had the advantage toward healing; amazing rapidity of epithelization on N.P. side; practically healed by 25th day. The last tiny areas were very slow in healing and repeatedly broke down	N.P., 103 C.L.O., 103

dressings. Culture: *Streptococcus hemolyticus* and *Staph. aureus.* There was progress on nickel pectinate regime to almost complete healing in 30 days. There was then a period of regression and final healing required 54 more days.

6. PATIENT N. S.—Lesion: Granulating burns of backs of both thighs that had been pinch-grafted 140 days previously. For 134 days Dakin's packs and gentian violet had been applied, but there still remained several pustules and a granulating patch 5 by 4 cm. in area. Culture: *Staph. aureus.* Healing occurred after 35 days of pectin therapy.

7. PATIENT F. L.—Lesion: Granulating areas in right orbit following evisceration operation for basal-cell epithelioma. Pinch grafts had been applied 135 days before. After 111 days of vaseline gauze and gentian violet treatment, the granulating areas were not reduced in size. Healing was complete after 21 days of nickel pectinate dressings.

The Use of Nickel Pectinate on Superficial Granulating Wounds.—The majority of these were granulating postburn wounds, but also included were denuded areas following radical mastectomy, excision of tumors, extensive incision and drainages, etc. Treatment was instituted shortly after the placing of pin-point grafts, and continued until final healing. Occasional cases that could not be reasonably kept on the ward until healing were followed for the final days in the outpatient department.

There were 40 of these wounds suitable for a comparison in rate of epithelization between nickel pectinate and control agents. Cod liver oil or cod liver oil ointment served as a control in all but 5 cases. In these 5 cases, foille was used three times and a 5 per cent sulfonamide ointment was used twice.

Eighteen of the larger wounds that were nearly uniform throughout were divided for treatment into two nearly identical halves, one half being dressed with nickel pectinate, the other with the control agent. These cases were outlined in Table I. As shown in Table II, the aver-

TABLE II

COMPARATIVE HEALING TIMES OF NICKEL PECTINATE TREATED AND CONTROL TREATED WOUNDS

AGENT USED	LARGE WOUNDS TREATED IN COMPARABLE HALVES WITH NICKEL PECTINATE AND WITH CONTROL		WOUNDS TREATED WITH ONE AGENT ONLY		COMBINED	
	NUMBER	AVERAGE DAYS UNTIL EACH HALF HEALED	NUMBER	AVERAGE DAYS UNTIL HEALED	NUMBER	AVERAGE DAYS UNTIL HEALED
Pectin	17*	35.7	15	24.2	32	30.3
Control (C.L.O. in all but 5 cases)	17*	43.8	7	26.7	24	38.8

*Case G. T. (See Table I) was not included here since his unduly prolonged healing time of 120 days should not fairly be included with the remaining 17 cases.

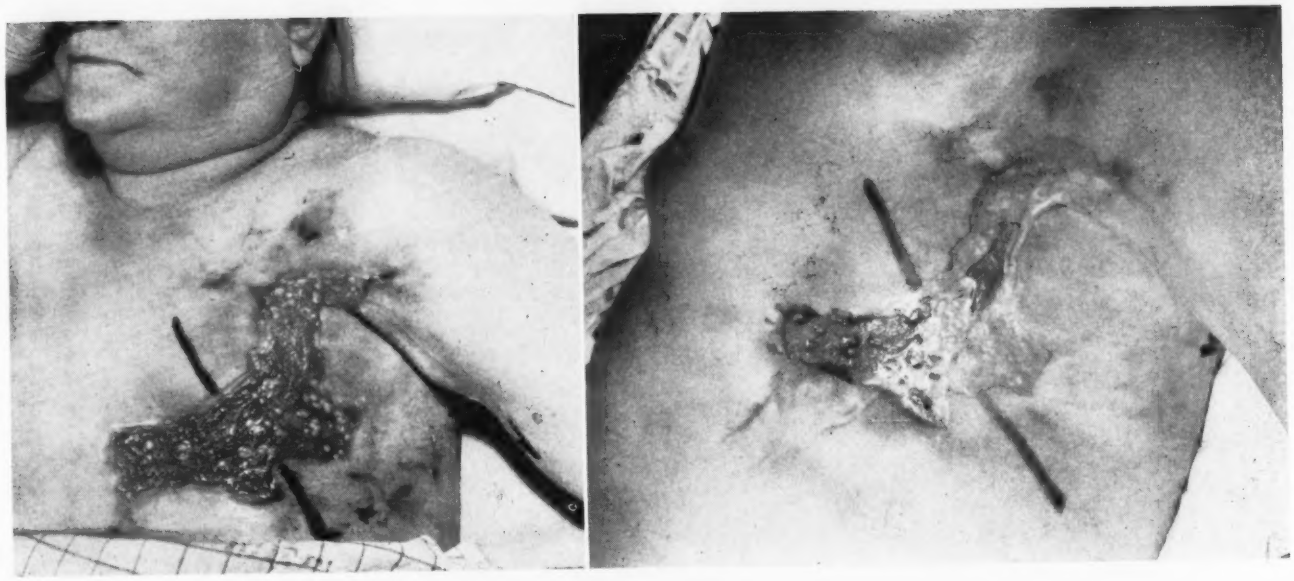
age healing time for the nipectin-treated half of the wounds was 35.7 days, for the control-treated, 43.8 days, or 22 per cent longer. In Table II is also compared the healing times of the other 22 miscellaneous superficial wounds, 15 dressed with nickel pectin, the remaining 7 with a control agent, usually cod liver oil.

A. *B.*

Fig. 1.—*A*, Patient L. S. at start, 8 days after pinch grafting. Upper half, above arrows, dressed with nickel pectinate jelly. Lower half, apparently identical, dressed with foille. *B*, Same patient 24 days later. Pectinate area practically healed. Note sharp transition between experimental and control areas produced by epithelization of pectin side.

Almost as striking as the reduction of epithelization time in these cases was the contrast in appearance between the two sides of the wound. The granulations on the nipectin side almost invariably remained smooth, flat, and rather pale, whereas on the control side they were rosy, hypertrophied, and bled easily. In case G.T. (see Table I and Fig. 3) when the nipectin side was nearly completely epithelized, there were granulations on the cod liver oil ointment side 9 mm. high! The healed pectin-dressed wound differs little from one that has received some other type of treatment. If anything, the skin in the former is smoother and more stable.

The Use of Nickel Pectinate in Deeper Wounds.—Noting the remarkable tendency of nickel pectinate in depressing granulation tissue over-



A. *B.*

Fig. 2.—*A*, Patient S. L. at start, 5 days after pinch grafting. Upper half, above marks, dressed with nickel pectinate jelly. Lower half, nearly identical, dressed with cod liver oil. *B*, Same patient 15 days later. Pectinate area nearly healed. Granulation tissue hyperplasia on cod liver oil side.

growth, we tested its effect in 5 comparatively deep infected wounds. Four of these were infected laparotomy wounds, the fifth an infected wound following a bilateral inguinal dissection for carcinoma of the penis. In 3 of these wounds (see Figs. 4, 5, and 6) the same control system already described was employed, namely dressing one half with nickel pectin jelly, the other half with cod liver oil or ointment. In from 7 to 10 days a remarkable difference was apparent between the nickel pectinate and the control side. The pectin granulations were pale, low, and smooth, those on the control side were rosy, exuberant, and much higher than on the experimental side. Biopsies taken from

Fig. 3.—Patient G. T., 22 days after start of experiment. Patient's left side treated with nickel pectinate jelly and now nearly healed. His right side dressed with cod liver oil ointment still shows hypertrophic granulations. Unfortunately, no initial photograph was taken. However, at the beginning, 6 days after pinch grafting, the two sides, with the exception of the infraclavicular regions, were nearly identical.

the contrasting areas of these wounds (Fig. 7) showed young, edematous, vascular granulation tissue on the cod liver oil side and condensed, older looking granulation tissue on the pectinate side. Final healing was recorded in only 2 wounds. In one (Fig. 4) both the nipectin and the cod liver oil-dressed halves were healed on the thirty-first day. In the other (Fig. 5) healing occurred on the pectin side in 71 days, on the cod liver oil side in 63 days. It is not surprising that healing in these excavated wounds was, if anything, slightly delayed by nickel pectinate therapy, since as already demonstrated, pectin retards granuloplasia.

The Use of Nickel Pectinate on "Dermatome" Splint-Thickness Donor Sites.—It appeared logical that if nickel pectinate dressings achieved their remarkable epithelizing effect chiefly by "holding back" granulation tissue overgrowth so antagonistic to skin healing, one portion of a split-thickness donor site, taken by a Pagett dermatome and dressed with nickel pectinate, should heal no more rapidly than another area of identical depth dressed with some control agent, since the base in both areas is made up of a residuum of corium that restrains granulation tissue overgrowth.

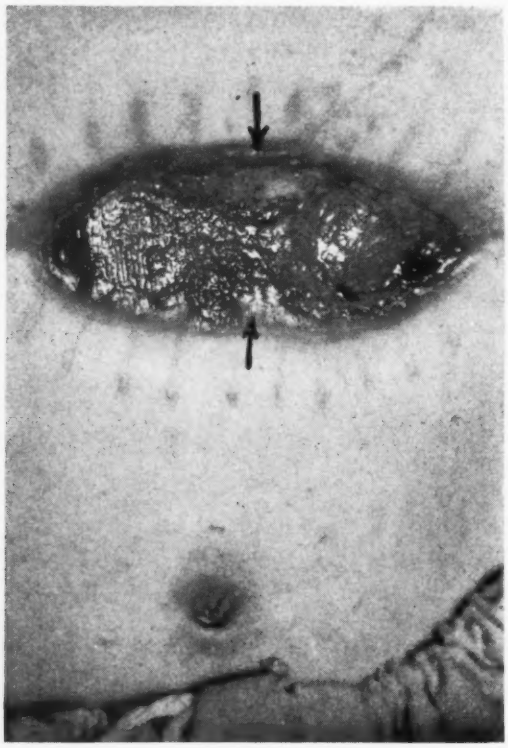
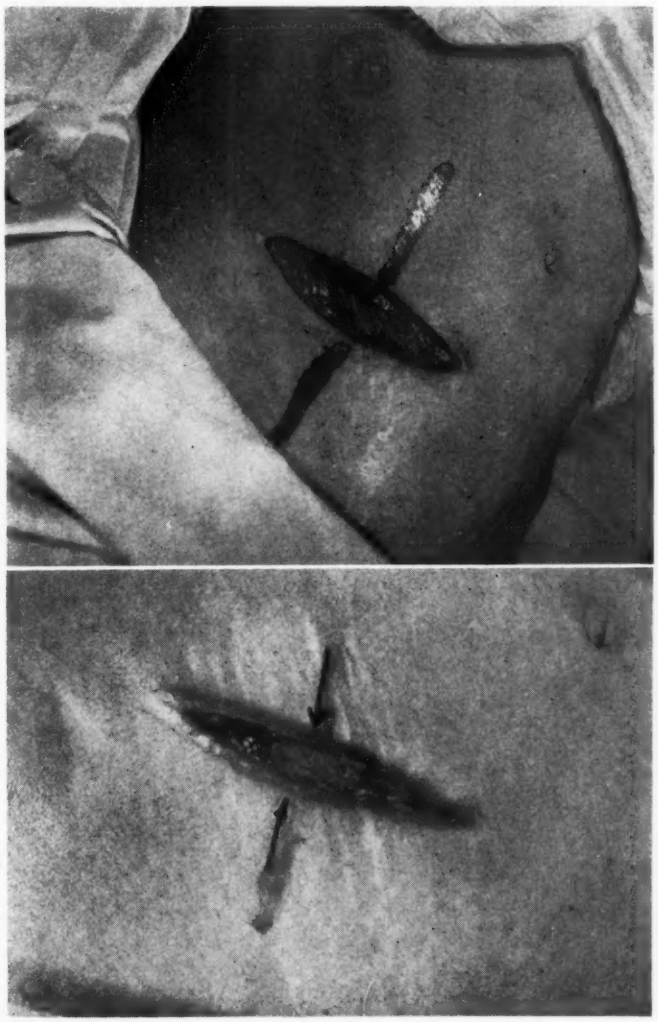


Fig. 4.—Patient W. B., Lesion, an infected, partly eviscerated, upper abdominal transverse incision, 18 days after start of bilateral dressings. Adherent anterior stomach wall formed one-half of the wound floor on the right, about one-quarter of the floor on the left. Nickel pectinate dressings on the right, cod liver oil on the left. Note that already granulations are luxuriant on the cod liver oil side and barely beginning on the pectinate side.

This experiment was carried out six times in 4 patients. Nickel pectinate dressings and cod liver oil or sulfonamide ointment dressings being applied side by side on the same area denuded about three-quarter thickness by the dermatome. As had been expected, healing was no faster on the experimental than on the control areas. In fact, the average healing time for the pectin areas was 18 days and for the control areas only 16.2 days. There was a striking difference in appearance between the two areas. The healed surface on the nickel pectinate treated

side was pale and absolutely smooth. The control-dressed surface was of a ruddy appearance and finely pebbled by virtue of tiny little granulations starting to push up through the corium but epithelized before they attained any size.



A.

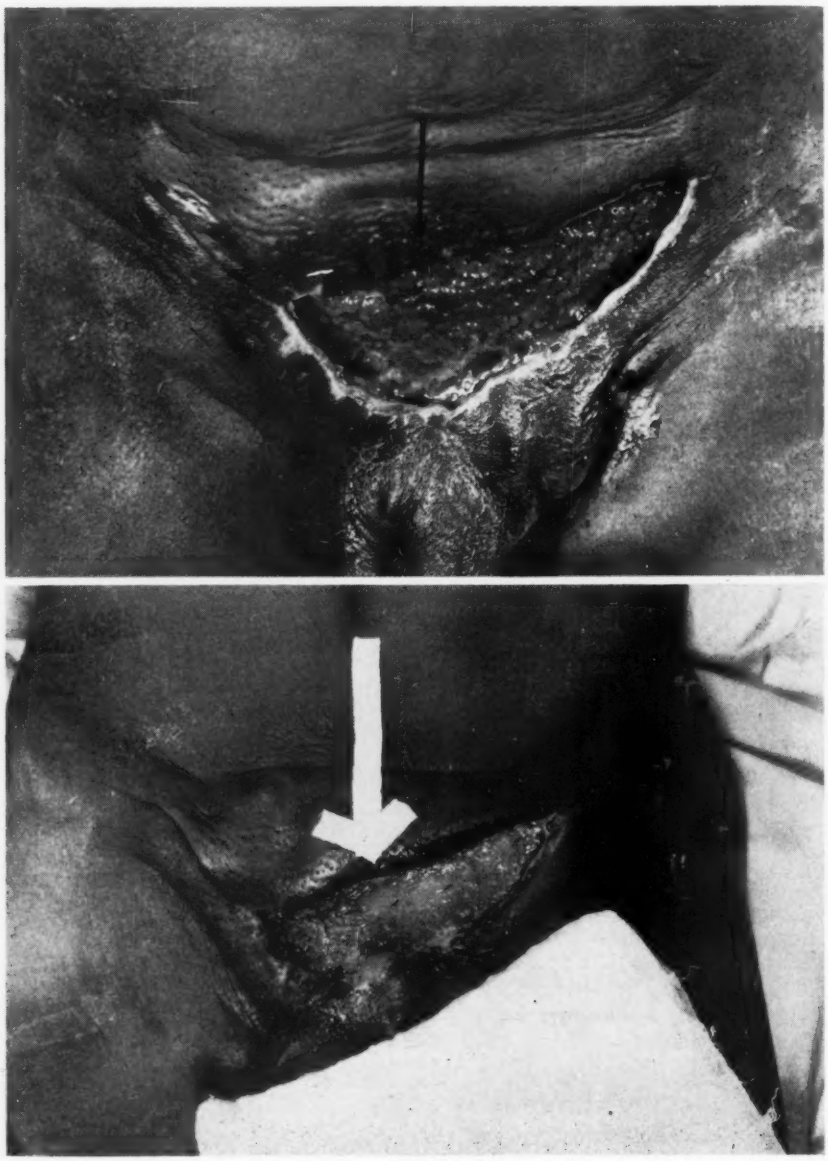
B.

Fig. 5.—*A*, Patient O. A., lesion, infected appendectomy wound at the start. Nickel pectinate dressings applied to medial half of wound, cod liver oil dressings to the right. *B*, Same lesion 14 days later. Note the flattened white granulations on the pectinate side, the exuberant granulations on the control side.

Cannon and Cope[8] compared the rate of healing of different areas of dermatome donor sites when dressed with different agents. However, the residuum of corium at the base of all such denudations restrains granulation tissue overgrowth and furnishes a myriad of foci for epithelial cell regeneration. A true test of epithelization can only be made on granulating surfaces devoid of any dermal remnants (see Discussion).

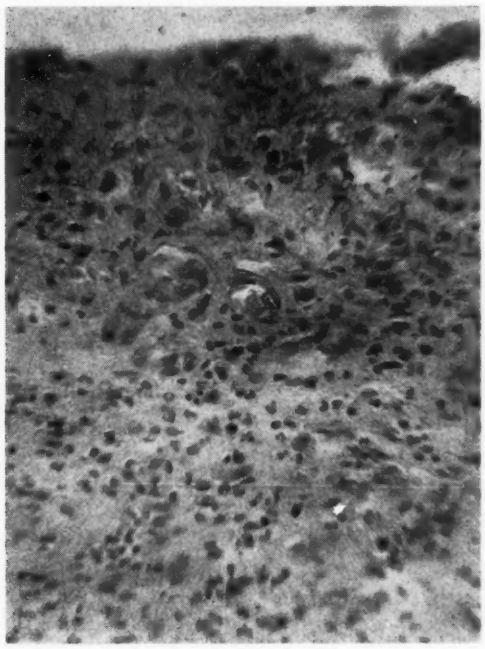
Bacteriology.—Nearly all of the wounds in this investigation were cultured one or more times. Since all had reached the granulating "surgically clean" phase before the start of the present study, little attention was paid to their flora, since experience has shown that by the time a wound enters the granulating stage it is usually adapated to its

A.



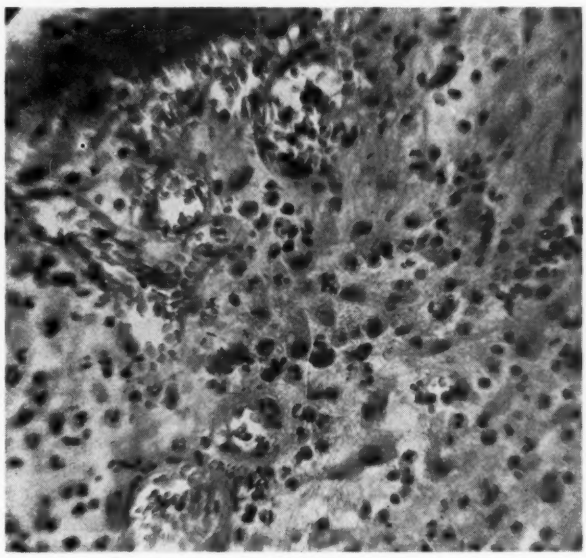
B.

Fig. 6.—*A*, Patient G. M., lesion, infected bilateral inguinal dissection wound for carcinoma of penis, at start of experiment. To patient's left, nickel pectinate jelly dressings; on the right side, cod liver oil ointment. *B*, Same patient 14 days later. On the pectin side the granulations are flat and whitened, on the cod liver oil side, they are high, turgid and rosy.



A.

Fig. 7.—Photomicrographs of granulating base of wound (Patient G. M., see Fig. 6)
A.—From nickel pectinate-dressed side.



B.

Fig. 7.—*B.*—From cod liver oil-dressed side. The cod liver oil side (*B*) shows very young fibroblasts, widely separated by marked intercellular edema. There are numerous blood vessels and rather dense infiltration of polymorphonuclear and plasma cells. On the pectinate side (*A*) the fibroblasts are more closely placed, their nuclei smaller and in places pyknotic. There is less vascularity and less leucocytic infiltration.

own organisms and that its rate of healing is not necessarily increased by reducing its bacterial count, unless virulent organisms are present. By far the commonest organism found was the *Staph. aureus.* The *Strep. hemolyticus* was fairly frequent while *B. pyocyaneus* and *B. proteus* were occasionally present. The average healing time for wounds culturing *Staph. aureus* alone (with or without lesser organisms such as *B. pyocyaneus* and *B. proteus*) was almost exactly that for wounds culturing both *Staph. aureus* and *Strep. hemolyticus*—37.2 days for the former and 37.1 days for the latter. On two occasions, however (patients D. B. and W. D., Table I), wounds that were practically healed went into a retrogression, their new epithelium melted away, and they became shaggy and purulent. Their culture, previously *Staph. aureaus,* now also revealed *Strep. hemolyticus.* In these two cases the intercurrent hemolytic streptococcus was doubtless virulent and responsible for the retrogression.

The nickel pectinate was definitely more bacteriostatic than its control, cod liver oil ointment. Exudate was usually less. On five occasions, after a wound had been dressed for from 7 to 9 days on one half with nickel pectinate and on the other with cod liver oil, colony counts were taken from both areas. Without exception the count on the control side was from two to ten times that of the experimental side.

RABBIT EXPERIMENTS

Nearly identical wounds were produced in 6 rabbits, one on either side of the spine, extending down to the paraspinal fascia and in one case through the fascia into the muscle. The skin borders (except in one case where circular incisions were made) were tacked to the underlying fascia. In each rabbit the wound on the right was dressed with cod liver oil ointment, that on the left with nickel pectinate jelly. The wounds were treated at least once daily, sometimes oftener. The gauze outer dressings were held in place fairly well by means of threads passed back and forth through skin clips that had been applied around the wounds in the normal skin.

Cultures taken after the sixth day showed a pure culture of *Staph. aureus* in all wounds. Four of the 6 cod liver oil-dressed wounds showed well-developed granulation tissue formation beginning about the seventh or eighth day. However, this never became an overgrowth such as frequently retards epithelization in human wounds. In the pectinate-dressed wounds there was never more than slight evidence of granulation tissue activity. Owing, doubtless, to the extreme looseness of the rabbit's hide, healing in all cases was chiefly due to contraction or cicatrization of the wound borders and involved only a slight amount of new epithelization. It is interesting that without exception healing came first on the cod liver oil side, occurring 15, 14, 13, 5, and 3 days

sooner, their average healing time being 32 days. A possible explanation for this relatively rapid healing of the control wounds is that since contraction of granulation tissue is one of the chief mechanisms of wound cicatrization, and since cod liver oil stimulates granulation tissue formation, cicatrization should therefore be accelerated in wounds dressed with this vitamin ointment. Nor is there in rabbits the tendency to granulation tissue overgrowth, the control of which in human beings gives pectin-dressed wounds the advantage during the stage of epithelization.

DISCUSSION

Wound healing, as pointed out by Alexis Carrel,[9] is not a simple and uniform closure of a defect by cell multiplication; it is a balanced cooperation between repair by granulation tissue and epithelization, each process governed by its distinct stimuli. Where the area of the wound is large in relation to its depth, the balance in healing is apt to be tipped in favor of granuloplasia, with the resulting familiar picture of "proud flesh" mushrooming out over the skin borders or burying in its depths pin-point grafts. From the foregoing, then it appears that nickel pectinate, by inhibiting granulation tissue overgrowth, restores a normal balance and allows epithelization to proceed at approximately its normal rate. Conversely, nickel pectinate will exert little if any effect upon the healing of a wound in which there is no exuberance of granulations.

The findings in this study are diametrically opposed to those of Tompkins,[11] Norton,[12] and their co-workers. These authors, the former on a basis of clinical experimentation, the latter from experiments on wounds in rats, both conclude that pectin and nickel pectinate promote wound healing up to the stage of epithelization, but actually retard the final proliferation and closing over of the skin. Possibly the pectin, the percentage of nickel, or the strength of merthiolate we have used may explain the difference in our results. Tompkins and associates used plain pectin 2 per cent, with merthiolate 1:200,000. Norton and coworkers used pectin 5 per cent, nickel 0.032 per cent, no mention of merthiolate. Our preparation contains pectin 3 per cent, nickel 0.045 per cent, merthiolate 1:5,000, and in most cases tragacanth 10 per cent. It is significant that Thomson's[5] first clinical trial of pectin revealed remarkable epithelization of an extensive granulating burn which other agents and several skin grafts had failed to heal.

Violle and Saint-Rat[13] and others have claimed that pectin is a hemostatic and hastens the clotting of blood. This is denied by Norton and colleagues[12] on a basis of in vitro experiments. I have observed that pectin does have an indirect hemostatic action in that it renders granulation tissue more dense, compact, and less vascular. Granulations dressed with other bland agents are turgid, rosy, and bleed easily, in contrast to the pale, flat, nonbleeding pectin granulations.

SUMMARY

1. The present study covers a period of four years during which time 65 wounds in 61 patients were dressed with nickel pectinate and as controls, 34 comparable wounds in 31 patients were treated with various bland agents, chiefly cod liver oil or ointment. In addition, controlled wound healing experiments were carried out in 6 rabbits.

2. An apparently satisfactory control method was employed in 22 cases, in which larger wounds, nearly uniform throughout, were divided into two comparable areas, the one dressed with the experimental agent, the other with the control.

3. Contrary to prevailing opinion, we have found that nickel pectinate does not promote wound healing, but instead depresses granulation tissue proliferation.

4. By virtue of its property of keeping down "proud flesh," nickel pectinate indirectly exerts a definite acceleration of epithelization (22 per cent reduction in healing time over such control agents as cod liver oil or foille). Hence, it is contraindicated in the early stages of wound healing, but is an ideal dressing where epithelization is sought.

5. Nickel pectinate is mildly antiseptic. Compared to cod liver oil ointment, it causes greater reduction in wound exudation and a marked reduction of the colony count.

6. Nickel pectinate is hemostatic to a certain point in that it condenses and renders less vascular granulation tissue with which it comes in contact.

REFERENCES

1. Block, L. H., Tornowski, A., and Green, B. H.: Pectin and Nickel Pectinate in Acute and Chronic Bacillary Dysentery, Am. J. Digest. Dis. **6**: 96, 1939.
2. Haynes, E., Tompkins, C. A., Crook, G. W., and Winters, M.: Bactericidal Action of Pectin Containing Compounds, Proc. Soc. Exper. Biol. & Med. **39**: 478, 1938.
3. Arnold, L.: The Bactericidal Action of Pectin and Metal Pectinates, Am. J. Digest. Dis. **6**: 104, 1939.
4. Myers, P. B., and Rouse, A. H.: Pectinates, With Special Reference to Nickel Pectinate and Their Therapeutic Value, Am. J. Digest Dis. **7**: 89, 1940.
5. Thomson, E. M.: Pectin in the Treatment of Infected Wounds, Indust. Med. **7**: 441, 1938.
6. Manville, I. A., Bradway, E. M., and McMinis, A. S.: The Use of Apple Powder in the Treatment of Diarrheal Conditions and Its Rationale, Canad. M. A. J. **36**: 252, 1937.
7. Smith, E. D.: Glycerin Osmotic Drainage, Am. J. Surg. **50**: 55, 1940.
8. Cannon, B., and Cope, O.: Rate of Epithelial Regeneration, Ann. Surg. **117**: 85, 1943.
9. Carrel, A.: The Treatment of Wounds, J. A. M. A. **55**: 2148, 1910.
10. Anderson, D. P., Jr.: The Problem of Wound Healing, Ann. Surg. **108**: 918, 1938.
11. Tompkins, C. A., Crook, G. W., Haynes, E., and Winters, M.: Pectin in the Treatment of Various Types of Wounds, Surg., Gynec. & Obst. **72**: 222, 1941.
12. Norton, P. L., Wilson, L. P., Johnstin, R., and Rosa, D. G.: The Effect of Pectin and Nickel Pectinate on the Healing of Granulating Wounds in Albino Rats, Am. J. Surg. **56**: 573, 1942.
13. Violle, H., and Saint-Rat, L.: Hemostatic Properties of Pectin, Compt. rend. Soc. de Biol. **180**: 603, 1925.

PLASMA CLOT SUTURE OF NERVES—ILLUSTRATED TECHNIQUE

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THE conventional method for uniting severed nerves has been by the use of thread stitches, preferably silk. Although an attempt is made to confine the stitches to the epineurium, nerve fibers are at times included with resultant strangulation of tissue and subsequent fibrosis. Further interference with successful regeneration may result from the knuckling of the nerve fibers when the threads are tied. The need for an improved technique is particularly apparent when dealing with small nerves where the silk sutures may strangulate a considerable proportion of the nerve fibers with great likelihood of unfavorable functional results. Young and Medawar[1] have attempted to avoid these difficulties by the use of cockerel plasma clotted with chick embryo extract. The inconveniences involved in the preparation of these materials and, more particularly, the inflammatory and fibrotic reactions resulting in animals of other species led to the introduction of the technique of autologous plasma clot suture of nerves.[2] Less obstruction to regenerating nerve fibers occurs with autologous than with heterologous plasma clot. The development of a suitable mold[3] in which nerves can be sutured with plasma clot has made possible accurate alignment and stronger union of the nerve ends. The technique of suturing peripheral nerves and nerve grafts by means of plasma clot has been described in previous publications.[3, 4] It was pointed out that when nerve ends cannot be united without tension, then plasma clot suture alone is undesirable since the junction may subsequently separate. Following a suggestion by Lt. Col. R. Glen Spurling, tantalum wire* (0.0025 or 0.003 inch in diameter) has been employed as tension sutures to approximate the nerve ends while accurate apposition is achieved by means of the plasma clot. The tension sutures are placed well back from the primary suture line and serve to protect it from strain. Single strands of untwisted 00 Corticelli black silk (or white silk) may be used as tension sutures. Although the silk is easier to tie than is the tantalum, it is not as strong and there is more risk of the silk breaking when the strain at the suture site is great. Moreover, the tissue reaction is greater with silk than

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*The tantalum wire was kindly supplied by the Fansteel Metallurgical Corporation.

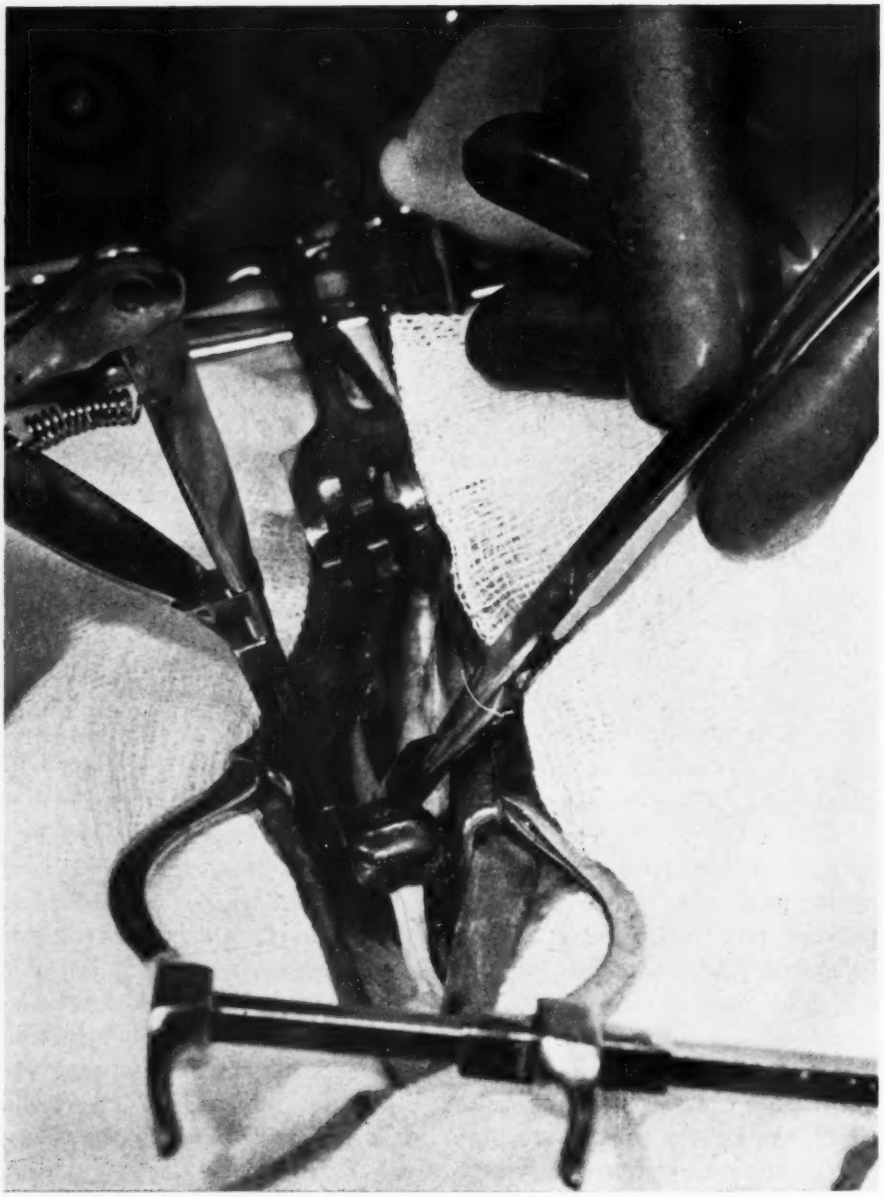

Fig. 1.—The nerve is held securely while the razor blade, mounted on a needle holder and introduced through the slot of the nerve holder, is in position for cutting the nerve. By this means one is enabled to obtain flat, cut surfaces of the nerve stumps which make possible better coaptation when joined with plasma clot. The use of layers of air-foam rubber within the jaws of the nerveholder enables one to hold the nerve firmly without traumatizing it.

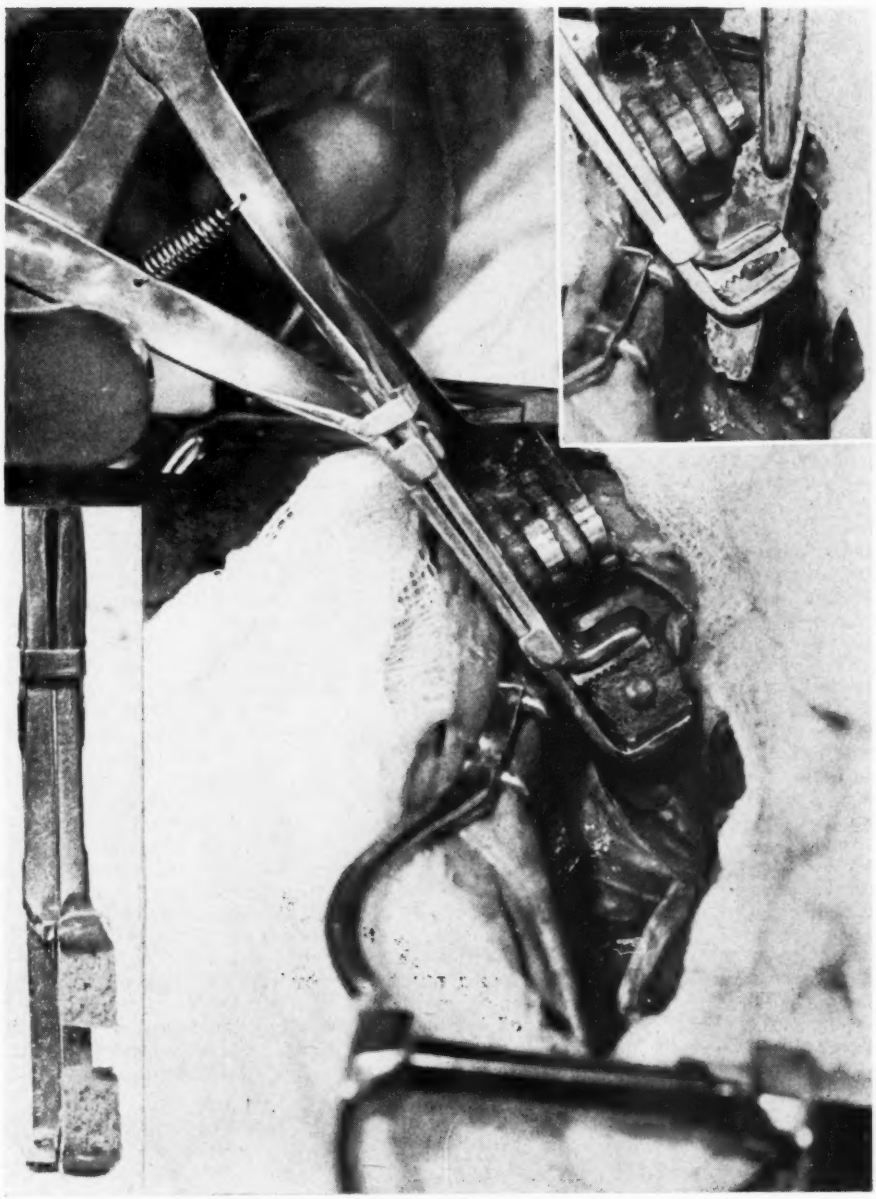

Fig. 2.—A nerveholder of the type shown in Fig. 1 is used for excising thin slices of nerve in order to obtain flat, cut surfaces or a normal pattern of nerve bundles when a neuroma exists. It differs from the nerveholder illustrated in Fig. 1 in that the upper and lower opposing jaws on one side of the slot are replaced by toothed jaws which hold the free end of the nerve securely while it is being trimmed. The nerve is shown in the groove of the air-foam cushions. The upper insert shows the free end of the nerve in the process of being excised, the razor blade having been introduced in the vertical slot which is shown in the front view of the instrument (lower insert).

Fig. 3.—The two tantalum wire tension sutures have been introduced at a distance of approximately 1 cm. from the cut ends of the nerve. The insert shows the manner in which the wires are applied. For the sake of convenience one end of the wire, threaded on a small curved ophthalmic needle, is bent sharply before it is introduced and it is then pulled through the nerve to the point of its angulation. (*A*). The tension sutures are carried somewhat deeper than the epineurium since in vitro tests of the tensile strength of nerves joined with tension sutures (tantalum wire or silk) have shown that the values obtained are almost twice as great when the stitches include a small amount of nerve substance rather than when they penetrate only as deep as the epineurium. The wire is then twisted so that one obtains a fairly straight pair (*B*) rather than two wires which tend to separate and assume a curved form due to the springiness of the metal. The length of the twisted pair of wires is made somewhat greater than the distance between the points of insertion of the tension sutures through the nerve when their ends are approximated. The wires are grasped by fine forceps and pulled backward; the length of the twisted pair of wires is thus shortened until the nerve ends may be approximated without strain. When this point has been reached, the long end of the wire is bent with a forceps as shown in *D*. The sharp bend prevents sliding of the nerve on the wire with ensuing separation of the nerve ends along their longitudinal axis. The very short twists which have been formed by pulling the wires backward (shown in *C*) act as a block to prevent excessive tightening of the wire when the ends are tied. The wires are tied in the form of a square knot (*D*) which is preferable to twisting the wires since the resulting sutures are thus rendered stronger. Both slipping of the wires and excessive tightening of them must be avoided since, should this occur, either a gap between the nerve ends would result or the stumps would be pressed against each other with knuckling of nerve fibers. Unless close apposition of the nerve ends is obtained, organization of the plasma clot insinuated between them would lead to the formation of connective tissue which interferes with the proper downgrowth of nerve fibers. On the other hand, if the nerve stumps are compressed as a result of excessive shortening of the wires, there results disruption of the proper longitudinal organization of the nerve fibers at the suture site. The manner of introducing and tying the tantalum wire tension sutures is given in detail since their correct adjustment is a most important step in the technique of tantalum wire-plasma clot suture of peripheral nerves.

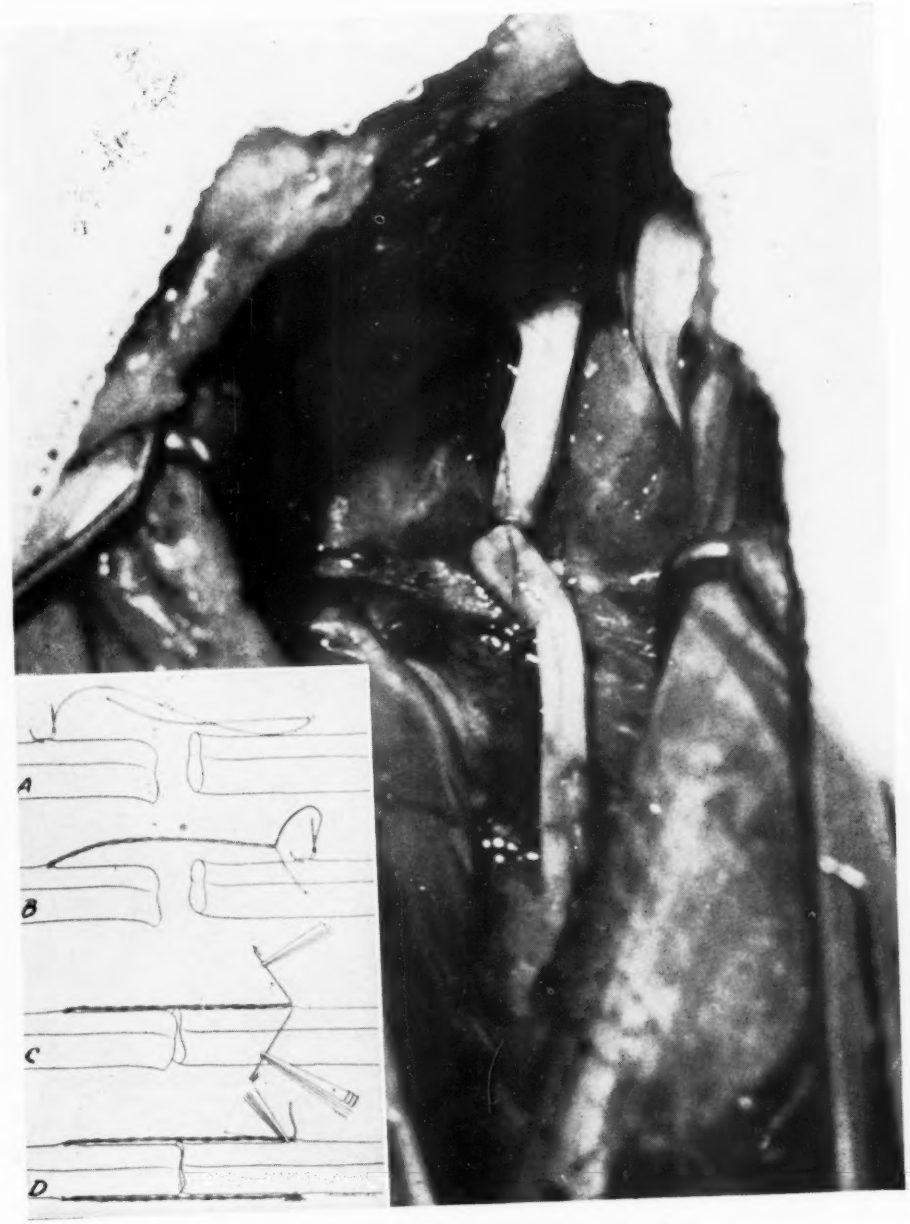

Fig. 3. *(For legend see opposite page.)*

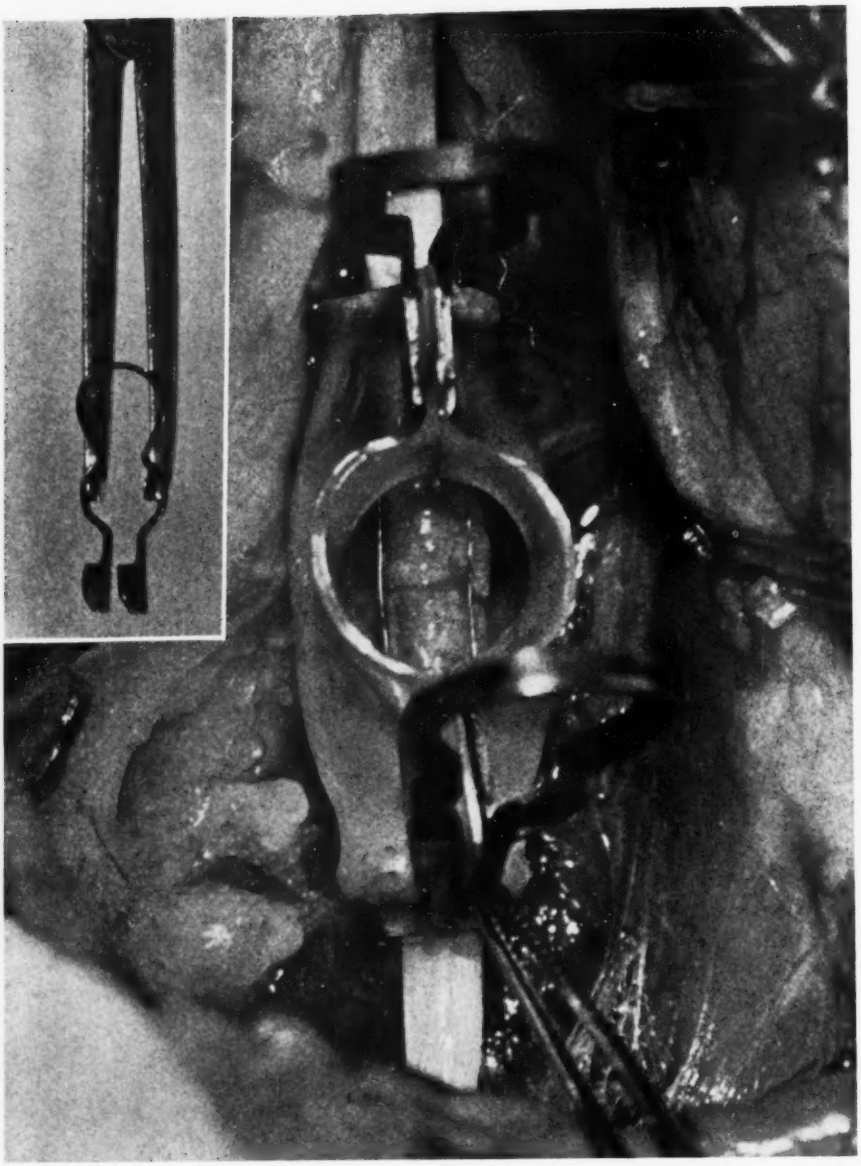

Fig. 4.—The nerve ends are adjusted on the wire rails so that accurate coaptation is obtained. The tension wires are shown. The clips have been applied to the fins of the mold as close as possible to the air-foam collar to prevent leakage of plasma from around the nerve. The insert shows the clip as it appears at the end of the clip holder. The mold is then filled with plasma, approximately 20 drops from a Wintrobe pipette. Originally a period of approximately twenty-five minutes was allowed before removal of the mold since this is the time required for the clot to achieve its maximum stability. However the clot becomes quite firm in about ten minutes and it is quite safe to remove the mold at the end of this period of time. The unmodified plasma (plasma to which no anticoagulant is added) is allowed to clot spontaneously since it has been found that the addition of most anticoagulants and coagulants to the plasma weakens the clots prepared from it. Recently, however, we have found that heparinized plasma coagulated by means of protamine sulphate yields clots which are as strong as those prepared from unmodified plasma. Heparinized plasma is prepared by adding 0.05 c.c. of liquaemin to 10 c.c. of blood and then 0.9 c.c. of the heparinized plasma is clotted by the

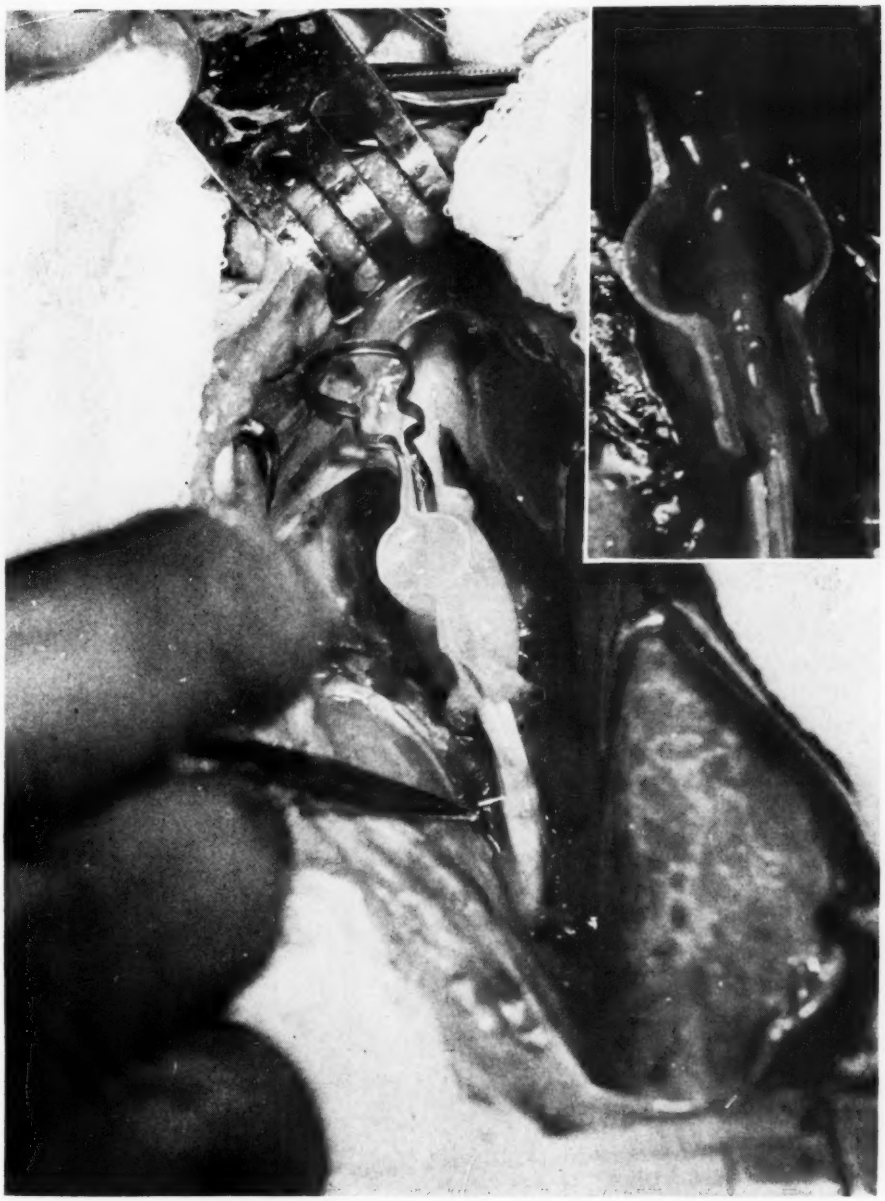

Fig. 5.—The handle of the wire rail is grasped by a forceps and is being withdrawn preparatory to removal of the mold. One clip has been removed. The upper insert shows the sutured nerve after both of the wire rails and clips have been removed and the mold carefully peeled away from the clot.

addition of 0.1 c.c. of a solution containing 0.125 mg. of protamine sulfate per 100 c.c. of distilled water. The heparinized plasma and the protamine are premixed immediately before being introduced into the latex mold for nerve suture. The use of heparin-protamine plasma offers a practical advantage in that the inconveniences involved in the preparation of unmodified plasma (collecting the blood in paraffin-lined test tubes packed in ice and centrifuging it in 250 c.c. metal cups filled with ice in order to prevent clotting) may be obviated. (Liquaemin by Hoffmann-La Roche, Inc.)

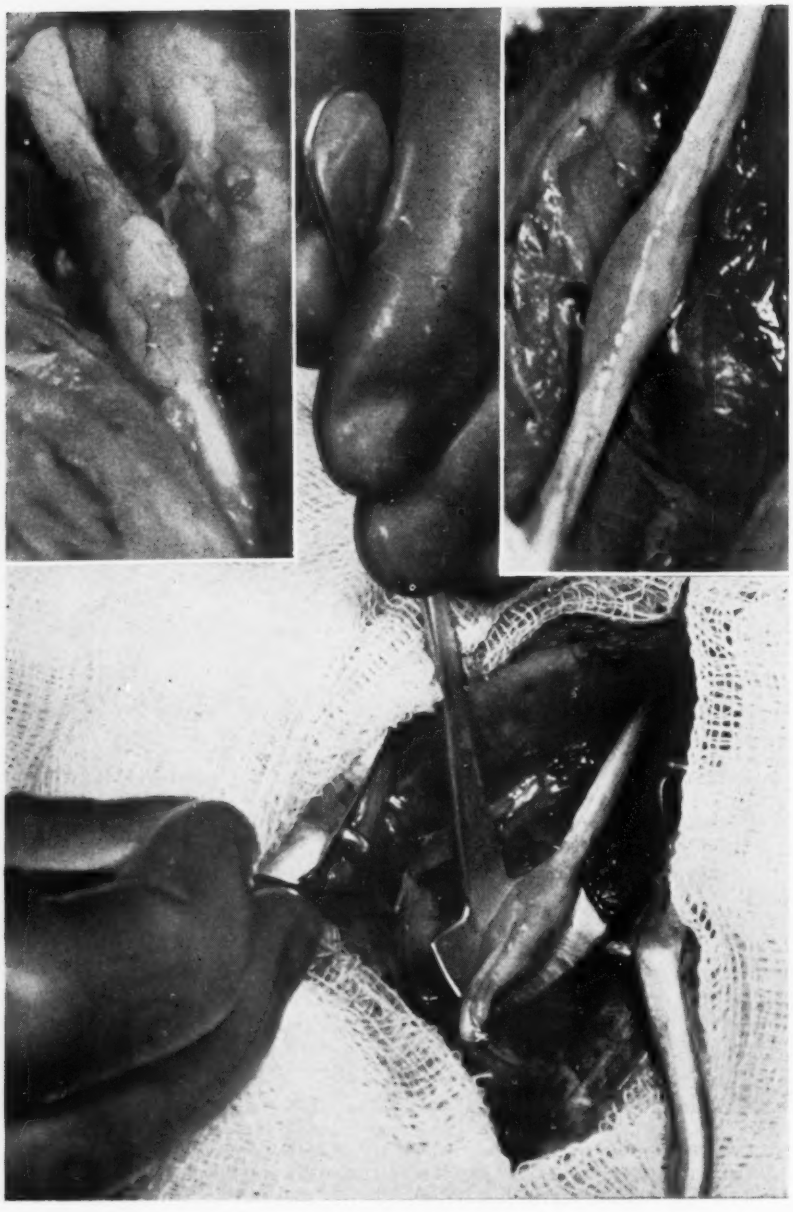

Fig. 6.—The mold is grasped by forceps and removed while the sutured nerve is protected by a spoon. The inserts show the nerve sutured by the combined tantalum wire-plasma clot technique. The tantalum wire is shown through the clot (left insert). Usually the opacity of the clot obscures the tension wires which are incorporated in it (right insert).

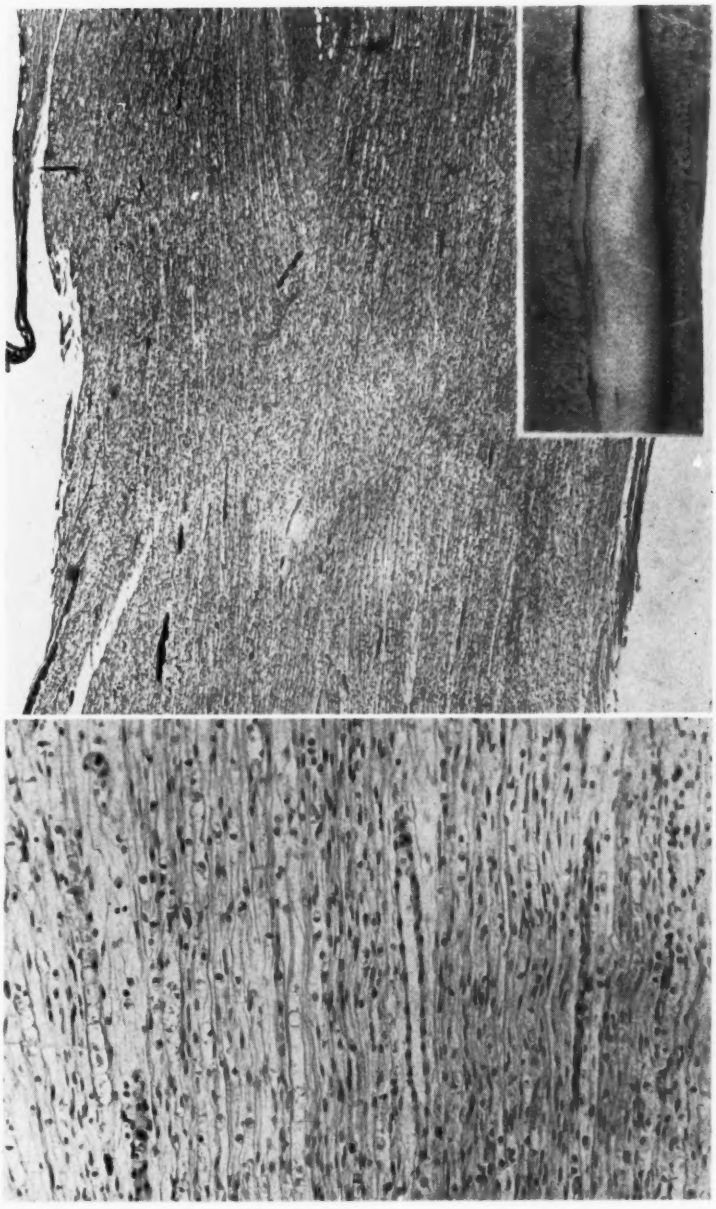

Fig. 7.—Photographs showing *A*, gross, and *B* and *C*, microscopic appearance of the sciatic nerve of a dog sutured by the tantalum wire-plasma clot technique. Note the tantalum wire tension sutures in the nerve (*A*) removed fifty-four days after suture. Photomicrographs show practically no inflammatory or fibrotic reaction at the junction thirteen days after suture. Sections stained with hematoxylin and eosin (*B* × 30; *C* × 140).

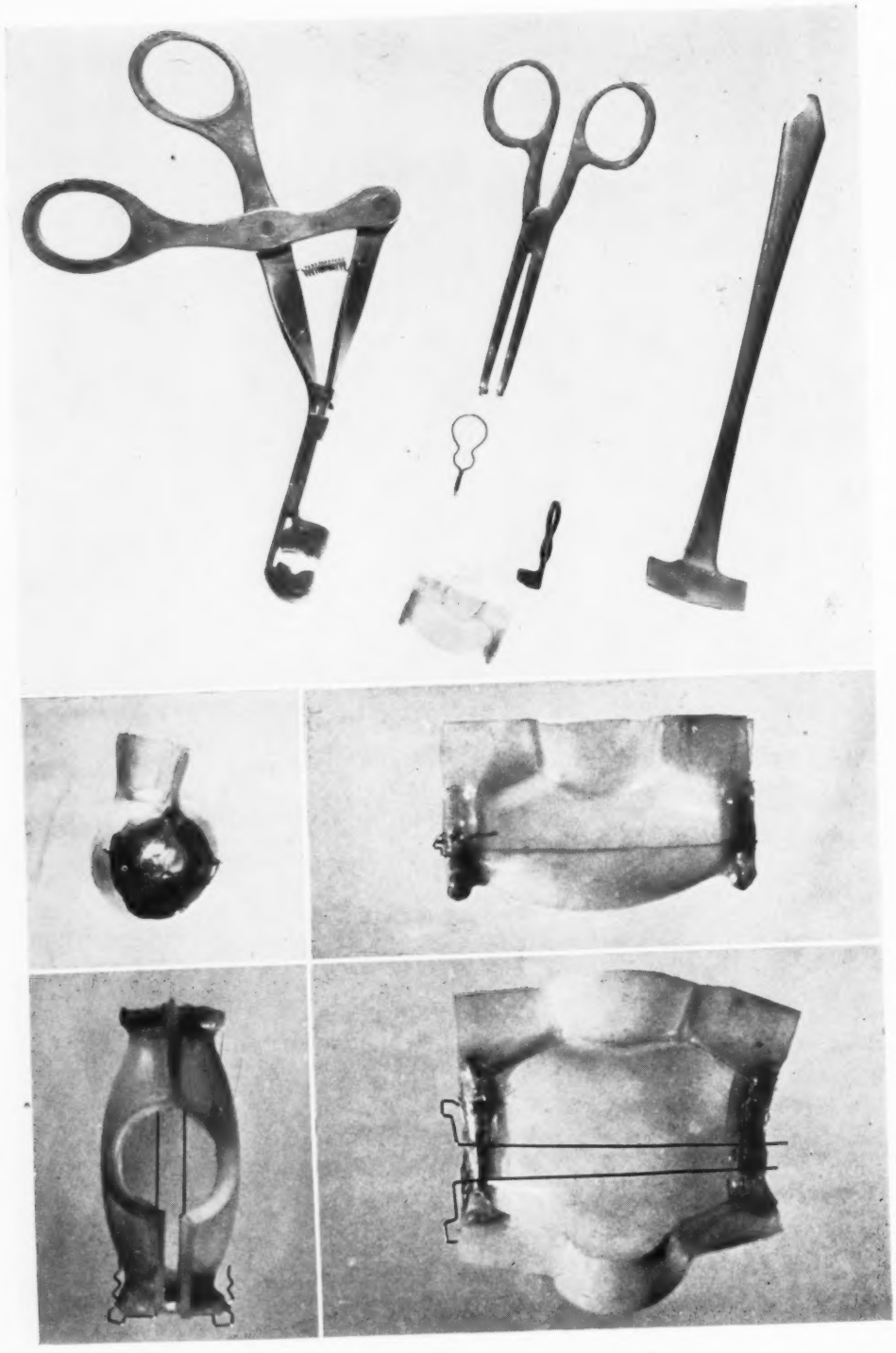

Fig. 8. *(For legend see opposite page.)*

with tantalum. It is the purpose of this communication to illustrate, mainly by means of photographs which have not been retouched, the technique of tantalum wire-plasma clot suture of peripheral nerves. The use of this combined technique eliminates the likelihood of separation of the sutured nerve ends. The photographs were taken at an operation upon the sciatic nerve of a dog.

Autologous plasma clot suture of peripheral nerves was done in five human patients.* In two of these cases sufficient time has elapsed for some evaluation of the results. In one case, functional recovery of the sternocleidomastoid muscle began two months after the spinal accessory nerve was sutured at a point approximately 4 cm. before its entrance into the muscle; complete recovery of muscle function occurred five and one-half months after the operation. The nerve had been sutured by depressing the nerve ends into the neighboring tissues to form a trough in which the plasma could collect. The nerve ends were held together with jeweler's forceps until clotting occurred. A suitable mold was not available at the time when this operation was done, so that this cruder technique had to be employed. The nerve was sutured one hour after it had been severed at operation. In another patient the ulnar nerve at the level of the wrist was sutured by the combined tantalum wire-plasma clot technique. The nerve, which had been severed fifteen months previously, was freed for a considerable distance proximal and distal to the stumps and the combined technique had to be used since the nerve ends to be united were under considerable tension. When last examined, eighteen week after operation, the patient had shown considerable return of sensation for pinprick, cotton-wool, and hot and cold objects over the hand and fingers down to and including the proximal half of the distal phalanx of the fifth finger. Before operation the area of sensory loss involved the fifth finger, the ulnar half of the fourth finger, and the inner part of the palmar and dorsal aspects of the hand as far as the wrist. Also during the interval between the tenth and eighteenth weeks postoperatively, there occurred improvement in the power of flexion of the fourth and fifth fingers and it has become possible to abduct and adduct the fingers to a slight extent.

*The author is indebted to Dr. Leo M. Davidoff and Dr. Thomas Hoen for referring these patients to him.

Fig. 8.—Photographs showing molds and instruments devised for plasma clot suture of nerves: nerveholder with grooved air-foam cushions, clips and clip holder, latex mold, and the spoon which is used for protection of sutured nerve during removal of mold. Below are shown end, side, top, and interior views of latex mold. The use of the wire supporting rails shown in the mold make it possible to obtain accurate apposition of the cut ends of the nerve and also to surround uniformly the suture site with plasma clot.

The molds are designed for nerves the size of the dog's sciatic nerve, and have a capacity of approximately 20 drops of plasma. For larger or smaller nerves, molds of appropriate sizes are kept on hand. The openings in the air-foam collars of the molds are made round and oval to accommodate variations in shape of nerves.

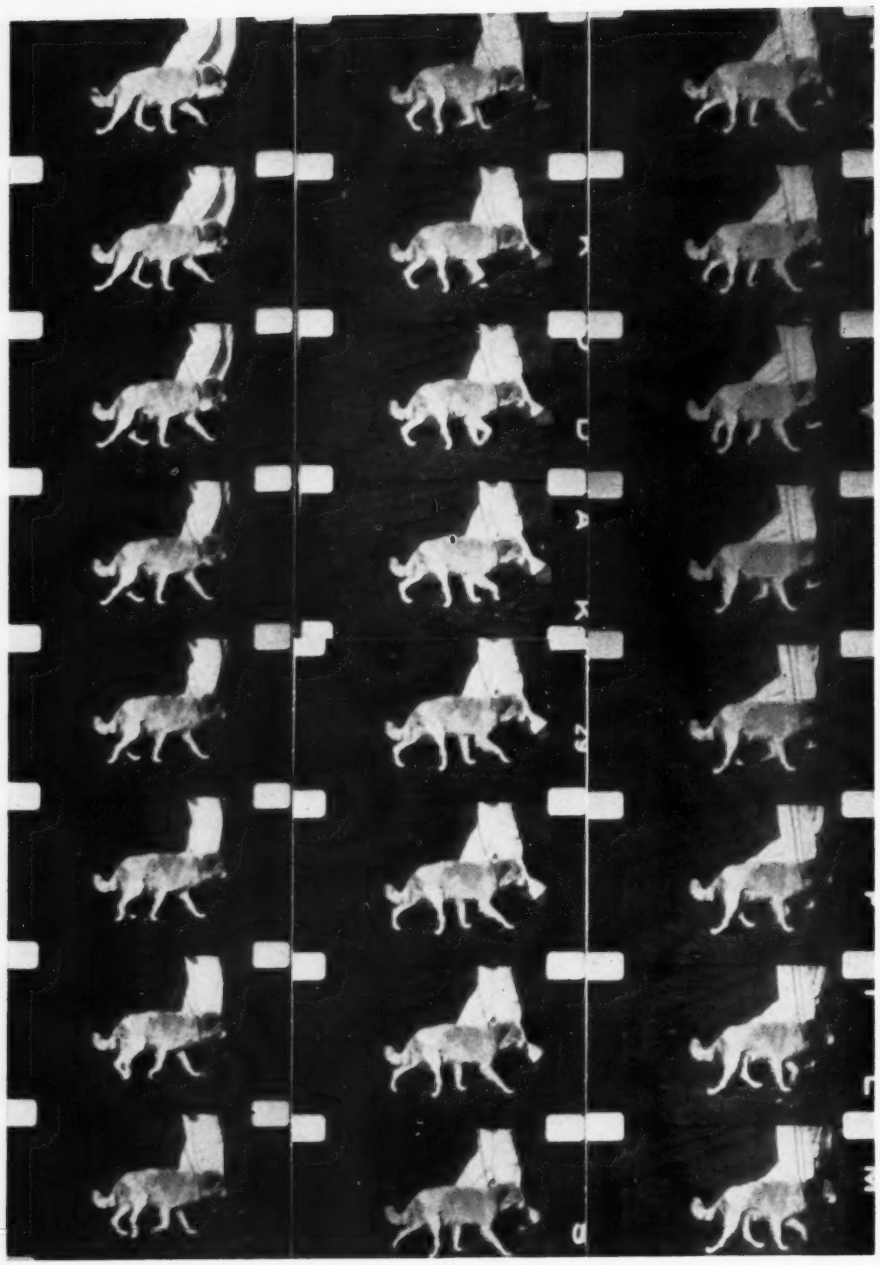

Fig. 9.—Series of photographs from a motion picture film showing complete cycle of movements of hind limbs of a dog in which the left sciatic nerve was sutured with autologous unmodified plasma and the right with silk (single strands of untwisted 00 Corticelli silk). Photographs were taken eighty-four days after operation, since which time complete recovery of motor power on the right as well as the left side occurred. Such a difference in the rate or degree of recovery of function which could be attributed to the different methods of suture has not been consistent in our animals, although the results tend to be better with autologous plasma clot suture. The superior gross and histologic results associated with plasma clot would lead one to anticipate correspondingly better functional return to the innerved part than with silk suture. Further correlative studies will be necessary to test this point.

The results of plasma clot suture of nerves are encouraging and justify further use of the method in cases involving human beings.

The molds and instruments used for the suture of nerves with plasma clot were made by Mr. Cornelius Denslow and Mr. Saul Swarz. The sketch which illustrates the technique of applying the tantalum wire tension sutures was made by Dr. Joseph A. Epstein to whom the author is also indebted for operative assistance. The photograph shown in Fig. 4 was taken by Mr. W. Abbey and those shown in Fig. 9 are from a motion picture film taken by Mr. Lester Bergman. Other photographs are by Louis Armonath.

REFERENCES

1. Young, J. Z., and Medawar, P. B.: Fibrin Suture of Peripheral Nerves, Lancet **2:** 126, 1940.
2. Tarlov, I. M., and Benjamin, B.: Autologous Plasma Clot Suture of Nerves, Science **95:** 1258, 1942.
3. Tarlov, I. M., and Benjamin, B.: Plasma Clot and Silk Suture of Nerves, Surg., Gynec. & Obst. **75:** 366, 1943.
4. Tarlov, I. M., Denslow, C., Swarz, S., and Pineles, D.: Plasma Clot Suture of Nerves: Experimental Technique, Arch. Surg. **47:** 44, 1943.

TENDON TRANSPLANTS WITH METAL NAILS

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TENDON transplantation, after its initial enthusiastic use, has in recent years been used less frequently in favor of more extensive arthrodesing operations in many instances. Among other reasons for the failure of tendons to work satisfactorily in their new positions are: (1) fibrosis and fixation in the sheath during the long period of immobilization necessary for bone attachment to become firm; (2) stretching of the healing area when sutured to soft tissue with resultant loss of efficiency and muscle tone; and (3) stretching at the point of bone insertion of a tendon weakened by long immobilization.

In a tendon transplanted and fixed to an area so that exercise and function can be begun early during the healing process, the formation of intrathecal adhesions and the loss of muscle tonus is avoided. Thus, the full muscle action is transferred to the new tendon location as desired. Also in tendons acting across joints, joint fixation and disability from long immobilization can be prevented by early function.

Such a surgical transplantation of a tendon can be done very simply by use of metal nail fixation of the transplant to firm bone and the early institution of function without external cast immobilization. When such procedure is done carefully with little trauma, much of the meticulous tendon sheath transplantation and special plastic pulley procedures may be neglected since the early institution of motion prevents adhesion formation. In the extremities a tourniquet is always used and a firm compression postoperative bandage has proved much superior to a cast.

This technique has been used successfully in lateral transposition of the anterior tibial tendon in talipes equinovarus (Fig. 1) from congenital, spastic, and paralytic origins and in replacement of the tibial tubercle with attached patellar tendon after operations on the knee joint (Fig. 3). Reattachment of the medial epicondyle of the humerus (Fig. 5) and the medial malleolus of the tibia (Fig. 2) has been satisfactory in recent traumatic injuries. Reattachment of the trochanter of the femur after approach to the hip joint and distal transposition of the trochanter to increase abductor efficiency are also practical (Fig. 4).

Nail fixation has been found excellent in reattachment of ruptures of the supraspinatus tendon at the shoulder, as well as tears of the long head of the biceps in this area (Fig. 6).

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Fig. 1A.

Fig. 1.—Lateral transportation of anterior tibial tendon with nail fixation; spastic equinovarus, no cast.

Fig. 1B.

Fig. 2.

Fig. 2.—Reduction of medial malleolus after fracture; early case, cast used.

Fig. 3.

Fig. 4.

Fig. 3.—Reattachment of tibial tubercle with attached patellar tendon after synovectomy; no cast, early function.
Fig. 4.—Reattachment of greater trochanter after arthroplasty; no cast, early function.

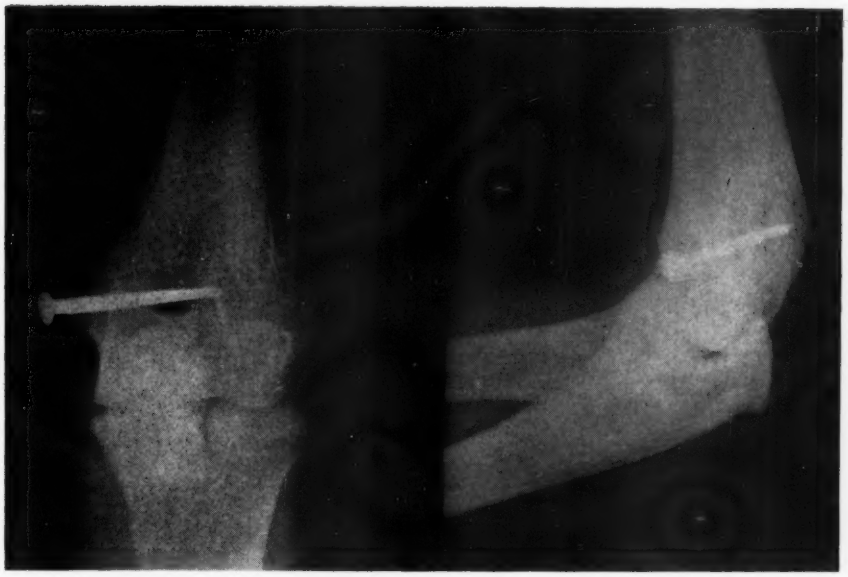

Fig. 5.—Reduction of medial epicondyle after fracture; no cast, early function.

Fig. 6.—Attachment of avulsed long biceps tendon origin to bicipital groove; no external immobilization, early function.

Screws have not been as satisfactory as nails in this work. The nail is inserted at an acute angle to the line of tendon pull when possible. Thus, tension on the tendon serves only to seat the nail more firmly. The surgical procedure is very short and consequently the patient's convalescence is rapid.

CONCLUSION

Nail fixation of transplanted tendons is rapid, simple, and effective. Early function is obtained by use of compression bandage instead of cast immobilization. Muscle tonus is maintained and tendon fixation is prevented by early motion.

THE TREATMENT OF INTERTROCHANTERIC FRACTURES OF THE FEMUR

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FRACTURES about the hip joint, because of their frequency and hazard to the lives of the aged patients in whom they occur, have received extensive consideration in recent years. Moreover, the problem has been so well defined that the treatment is now specifically directed to the special types of fractures involved. In this process of clarification between fractures in the neck of the femur and fractures in the trochanteric region, more attention has been directed to the neck fractures since they pose more difficult problems of care and treatment. As a result, the trochanteric fractures have not received such concentrated study because they were considered to be less common, easier to treat, and less likely to be followed by nonunion. Closer study of the problem, however, does not bear out this conventional casual view.

In the first place, fractures in the region of the trochanters occur in older patients and consequently are followed by a much higher death rate than fractures of the neck. Again, trochanteric fractures, since they are usually produced by more serious injuries, generally produce more pain and shock than neck fractures. Trochanteric fractures also are more varied in type and may range from simple cracks through the intertrochanteric region without displacement to severely comminuted fractures with gross deformity.

INCIDENCE

In Key's observations at the St. Louis City Hospital, 56 per cent of all hip fractures were intertrochanteric in type. Morris found at Tulane that there were four times as many intertrochanteric fractures as intracapsular fractures. In a group of 136 fractures of the hip which I have seen during the past three years, 65 or 47.8 per cent were intertrochanteric. Thus, we see that there are roughly as many fractures in the region of the trochanters as there are in the neck of the femur, so that the problem of their care is just as important.

The comparative ages of patients in these two groups are shown in Table I.

TABLE I

FRACTURES OF THE FEMUR	AVERAGE AGE (YR.)
Of the neck	66.4
Trochanteric	70.1

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As is well known, there is considerable difference between the sexes in the occurrence of these fractures. In 136 cases of all types of hip fractures which I have seen, occurrence was found, as shown in Table II.

TABLE II

FRACTURES OF THE FEMUR	MALES (PER CENT)	FEMALES (PER CENT)
Of the neck	25.3	74.7
Trochanteric	54	46

In general, therefore, it can be said that more than half the cases of trochanteric fractures occur in men and nearly two-thirds of the cases of neck fractures occur in women.

A similar characteristic variation is found in the hips involved, as shown in Table III.

TABLE III

FRACTURES OF THE FEMUR	LEFT HIP (PER CENT)	RIGHT HIP (PER CENT)
Of the neck	62	38
Trochanteric	47.8	52.2

MORTALITY

That intertrochanteric fractures result in high death rates has been commonly noted. Wilson, at the Massachusetts General Hospital, reported 24 per cent mortality in a group of 62 cases; Leyding, at the St. Louis City Hospital, found 39 per cent mortality; and Taylor, in Los Angeles General Hospital, found 30 per cent mortality. Of 65 intertrochanteric fractures which I have followed, 15 patients died within two months of the accident (22.2 per cent mortality). These observations lead to the obvious conclusion that intertrochanteric fractures are a most potent cause of death in the aged.

CLASSIFICATION OF TROCHANTERIC FRACTURES

Many years ago, Percivall Pott stressed the importance of determining the type of hip fracture before instituting treatment because "they so often lame the patient and disgrace the surgeon." Sir Astley Cooper was the first to emphasize the difference between the intracapsular (neck) fractures and the extracapsular (trochanteric) fractures in relation to their probability of union.

The older writers divided trochanteric fractures into (1) comminuted fractures at the base of the neck and (2) "mixed" fractures at the base of the neck. The "mixed" fractures were partly intracapsular (on the front surface of the neck) and extracapsular (on the posterior surface of the neck) because of the uneven attachment of the capsule. Pertro-

chanteric fractures were identified as those which passed through the base of the neck and shaft distal to the greater trochanter and proximal to the lesser trochanter. Subtrochanteric fractures were those which occurred in the shaft just distal to the lesser trochanter.

Böhler's description of the principal types of trochanteric fractures of the femur seems as nearly adequate as any:

1. Fracture through the base of the neck outside the capsule with slight displacement.

2. Fracture through the trochanters with outward rotation of the leg and wide separation of the fragments.

3. Fracture with the base of the neck driven deeply into the spongy mass of the trochanters.

4. Fracture line in the region of the trochanters, often with comminution.

Fig. 1.—Simple type of fracture through the base of the neck of the femur with no displacement.

Of course as in all fractures, there are many diverse types of trochanteric fractures which may or may not conform to this broad classification. Moreover, there are wide differences in the degree of comminution or displacement of fragments which may have much to do with the choice of proper treatment (Figs. 1 to 5).

Fig. 2.—Comminuted fracture through the intertrochanteric region with rotation deformity of the leg and impaction of the base of the neck into the shaft of the femur.

Fig. 3.—Comminuted fracture through the intertrochanteric region with marked upward displacement of the shaft of the femur.

TREATMENT OF TROCHANTERIC FRACTURES

Unlike fractures of the neck, the treatment of trochanteric fractures is not complicated by the prospect of nonunion. There is a very liberal blood supply to the trochanteric region even in aged adults and each fragment is adequately supplied despite the presence of the fracture. I have never seen a nonunion of a trochanteric fracture and none has been described in case reports as far as I know. The main problem, therefore, is to secure union in normal position without coxa vara deformity, shortening, or external rotation rather than concern about nonunion.

Fig. 4.—Comminuted fracture distal to the greater trochanter with angulation of the fragments.

The following types of treatment have been used with varying degrees of success:

1. External splints
2. Traction devices
3. Internal fixation with nails, screws, bolts, etc. It is worth while to consider each plan of treatment with the advantages and disadvantages in order to decide the best type of care for these cases.

1. *External Splints.*—The first splint for fracture of the hip was described by Ambroïse Paré, who treated "an honest matron" by placing wooden strips about her thigh and supporting them with a figure-of-eight bandage about the thigh and waist.

In 1871, Hodgen of St. Louis described his wire suspension splint which supported the extremity in a long sling, although it provided no immobilization of the body. This splint has been popular for many years and is still widely used.

An oft-described, but apparently seldom used, hip splint was the Thomas-Ridlon splint (1880). This cumbersome device consisted of a long broad strip of soft iron which passed up the back of the leg and thigh across the buttocks and up to the shoulders. It was bent to conform to the body and was fastened to the patient with straps.

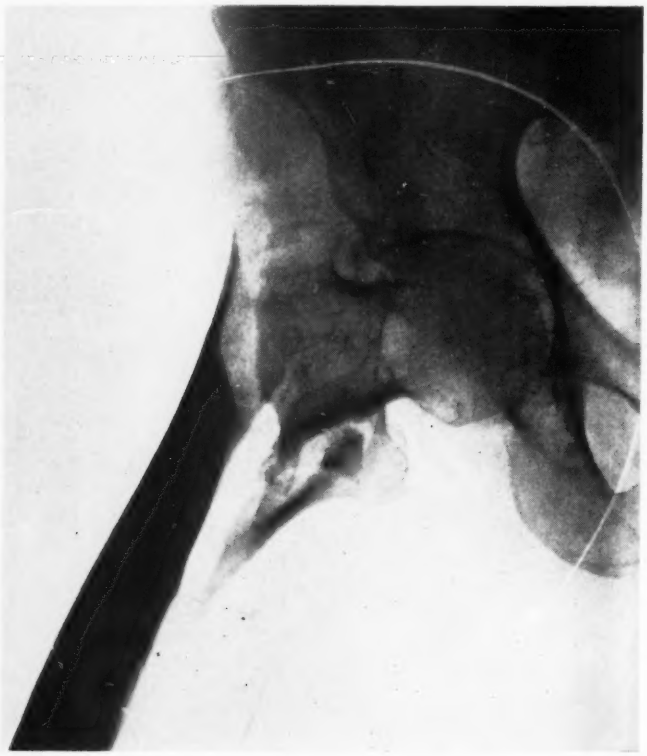

Fig. 5.—Long spiral fracture in the intertrochanteric region with moderate displacement.

Although Senn illustrated a plaster of Paris spica bandage, in 1889, with a lateral pressure screw over the trochanter, the greatest credit is due Royal Whitman who, in 1904, described the abduction spica cast. But Whitman's more significant contribution was the accompanying description of the maneuvers for reducing hip fractures and the recognition of the importance of abduction and internal rotation for locking them after reduction (Fig. 6).

Wilkie attempted to achieve the same position by using casts on each leg which were joined by metal rods to maintain abduction and internal rotation.

External splinting alone, of course, facilitates the healing of trochanteric fractures, but it is not adequate treatment for comminuted

fractures or those with great displacement. The Whitman cast is the only splint which attempts to secure the fragments in normal position, although its usefulness is limited to the simple fractures at the base of the neck.

A great criticism of all external splints is that they confine the patients to such a degree that change of position is rendered difficult. This encourages the formation of pressure ulcers, muscular wasting, and residual joint stiffness which may delay general recovery.

It is plain, therefore, that external splints find their principal role in the treatment of those patients who are too frail to permit the use of internal fixation. Yet, strangely enough, this so-called conservative treatment is attended by such a high death rate that it cannot be considered as an ideal emergency treatment.

Fig. 6.—Oblique fracture through the trochanteric region which was reduced by the Whitman method and immobilized by the abduction cast; solid union in normal position.

2. *Traction Devices.*—The first effort to overcome the shortening of trochanteric fractures by the use of traction was made by Hildanus about 1600, when he advocated a strap about the knee which was attached to ropes and pulleys at the foot of the bed.

In 1850, Gibson of Philadelphia devised a traction splint which utilized the principle of countertraction through the sound leg. Traction on the feet was secured by a tight cloth gaiter.

A great advance in the comfort of patients followed Gurdon Buck's introduction, in 1861, of the familiar adhesive skin traction which was attached to cords and weights at the foot of the bed.

Maxwell (1871) and Ruth (1891) combined longitudinal traction with lateral traction to overcome outward rotation of the leg and to produce more accurate reduction of the deformity.

Fig. 7.—Intertrochanteric fracture with no displacement, securely anchored with two long vitallium screws.

In 1921, Russell described his complex "balanced traction" which provided force in two lines so that the knee and thigh each received proper support while longitudinal traction was maintained.

A simpler and better known method of securing traction is the use of adhesive extension while the leg is suspended in a standard Thomas ring splint.

In 1932, Roger Anderson improved the well-leg traction plan by the use of two leg casts fastened to an adjustable apparatus between the legs. Carl Jones utilized the same principle in a device which likewise produced traction on the fractured leg while providing countertraction through the sound leg.

While traction is desirable in most trochanteric fractures to overcome the tendency to shortening and angulation of the neck, it has the disadvantage of holding the patients in the supine position. This in turn increases the likelihood of bed sores and hypostatic pneumonia and, because pain often persists, sedatives are required which in themselves depress the patients.

Well-leg traction in casts permits patients to be turned or to be placed in a wheel chair but, since the knees and ankles are held immobile for many weeks, there is much residual stiffness and weakness after the fracture has healed.

Fig. 8.—Intertrochanteric fracture immobilized in normal position with two vitallium screws.

3. *Internal Fixation.*—The earliest successful internal fixation of intertrochanteric fractures was developed by Denegre Martin of New Orleans, who advocated the use of two long carpenter's screws placed parallel across the fracture line into the neck and head of the femur. Brewster has reported extensive use of the method and has advised long vitallium screws which are less likely to irritate the tissues than the ordinary iron screws (Figs. 7 and 8).

In 1915, Preston described a screw-plate which consisted of a long screw, to penetrate the head and neck, with a plate that was fastened to the shaft of the femur with screws (Fig. 9).

Austin Moore's adjustable pins which were originally devised for fractures of the neck of the femur have been successfully adapted for those trochanteric fractures which are not comminuted.

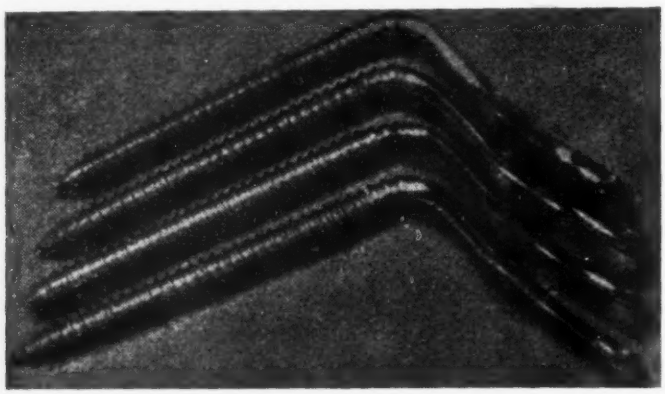

Fig. 9.—Preston's screw-plates for immobilization of intertrochanteric fractures.

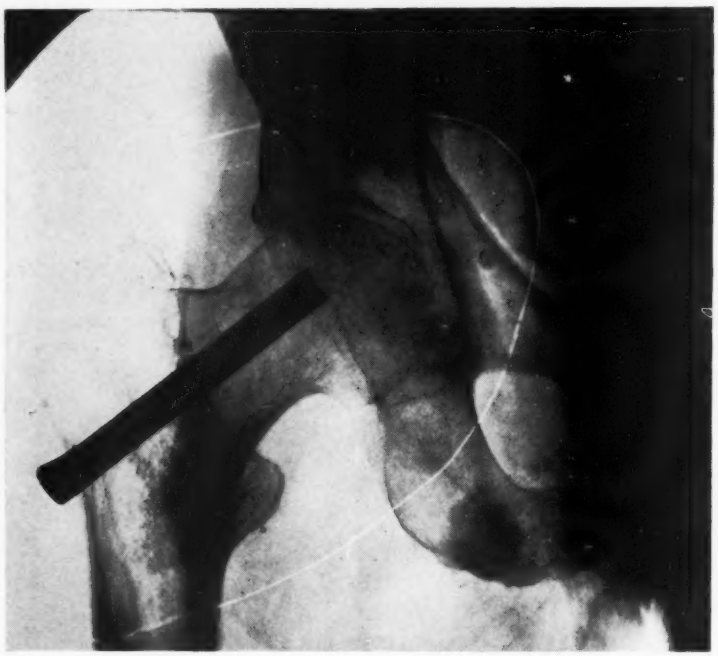

Fig. 10.—Fracture through the trochanteric region secured by vitallium Smith-Petersen nail.

In the same way, the flanged Smith-Petersen nail has been advocated for intertrochanteric fractures as well as for intracapsular fractures of the neck (Figs. 10 and 11). Thatcher has modified it with a screw which is passed through the head of the nail into the shaft of the femur.

In 1937, Lawson Thornton conceived the idea of screwing an extension plate onto the end of the Smith-Petersen nail in order to provide more

support for fractures in the subtrochanteric region and to prevent the coxa vara angulation which often follows use of the nail alone (Fig. 12).

Overton has suggested the use of a knurled nail head and a knurled intertrochanteric plate to prevent the tendency to loosening which has been reported in cases of plates screwed onto the end of the nails. In Overton's series of 43 cases in which this plate has been used, there has been no case of varus deformity in the late stages of healing.

McKibbin has utilized fixation pins in the upper end of the femur, which were incorporated in a plaster cast about the thigh in order to leave the hip and knee free.

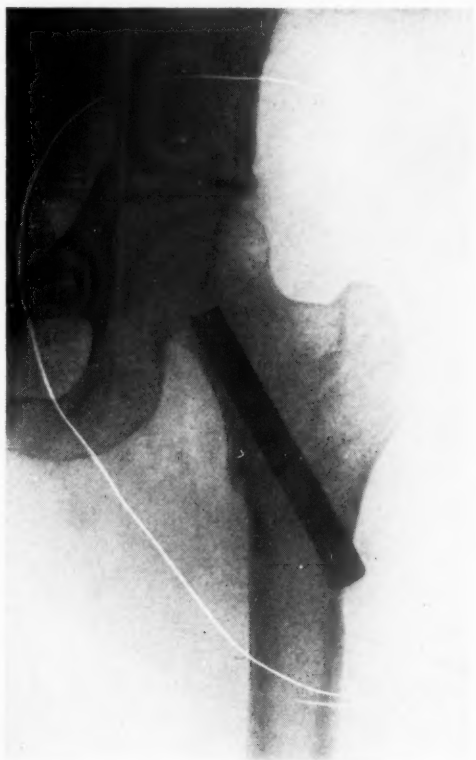

Fig. 11.—Pertrochanteric fracture immobilized by vitallium Smith-Petersen nail.

Roger Anderson recommends fixation pins through the fracture and the shaft of the femur with external bars anchoring all the pins into one unit (Fig. 13). This is a further adaptation of the various Anderson external splints for supporting fixation pins in fractures. In flabby obese patients, however, the soft tissues must be supported by a cast or pads to prevent irritation about the pins and loosening of them.

The numerous appliances which have been developed specifically for fractures of the neck have also been suggested for use in trochanteric fractures. Leydig and Brookes have utilized the Henderson lag screw,

Lippman has adapted his corkscrew bolt, and Morrison has altered his lock bolt by the addition of a plate to anchor the head and neck to the shaft.

Several authors have devised nail-and-plate units suited especially for trochanteric fractures. Neufeld proposed a V-shaped nail in the neck which merged with a flat plate fastened to the side of the shaft with

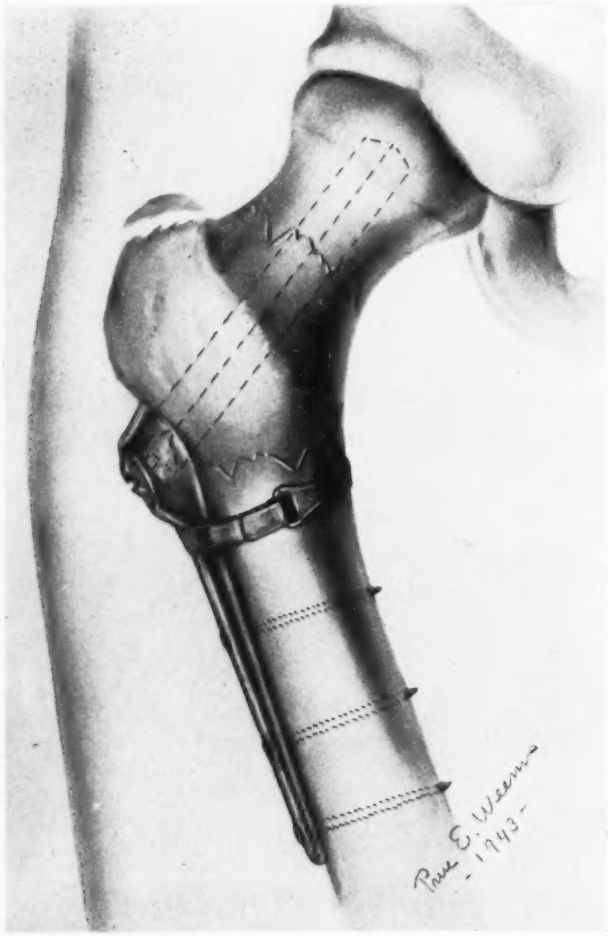

Fig. 12.—Lawson Thornton's plate which is fastened to a Smith-Petersen nail by means of a screw, and to the shaft of the femur with screws or bands. (Courtesy of Lawson Thornton.)

screws. Austin Moore has recently introduced his blade plate which is a simple curved piece which impales the head and neck and conforms to the side of the shaft of the femur. He has used it in 34 cases and has also made the plates in varying lengths to accommodate fractures with much comminution (Fig. 14).

The Jewett nail is a single appliance made of a vitallium Smith-Petersen nail with an attached flat plate to fit the shaft of the femur (Figs. 15 and 16).

Compere has recently recommended the use of a metal plate which is fastened to the shaft of the femur with screws. Threaded pins are then passed through the plate to anchor it to the head and neck of the bone.

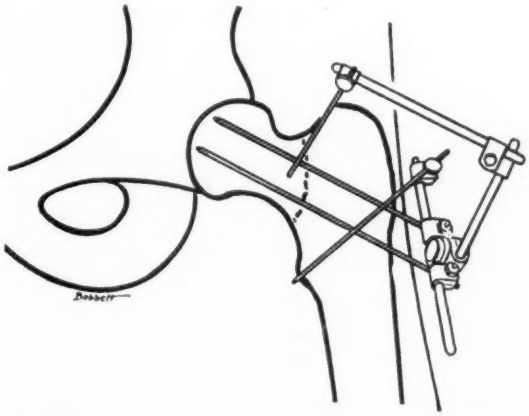

Fig. 13.—Roger Anderson fixation pins and external bars to support fractures in the trochanteric region. (Courtesy of Anderson, McKibbin, and Burgess.[2])

Fig. 14.—Austin Moore's single angle blade plate for intertrochanteric fractures.

Modern anesthetics of much less shocking action and reaction-free intravenous solutions have made surgical operations on elderly patients much less hazardous than in former years. Moreover, since patients with

trochanteric fractures can anticipate poor results with so-called conservative treatment, it is advisable to consider internal fixation of these fractures whenever possible.

A patient with properly applied internal fixation of the fracture experiences little pain and consequently requires few narcotics. The nursing care is simpler, positions can be changed easily and without discomfort, and long hospitalization is unnecessary.

Fig. 15.—Jewett angle nail providing fixation of a displaced fracture in normal position.

Nails, screws, or bolts alone are satisfactory if the fracture is at the base of the neck with little displacement, and if there is an intact lateral cortex. A hazard in the use of such appliances, however, is the frequency of fracture lines into the greater trochanter, which weaken it as a support for the nail. As a consequence, nails may come loose and a coxa vara deformity result. Also, in the operation the lateral cortex sometimes splits and thus provides no adequate support for the nail.

The more recently developed nails (Neufeld's, Moore's, and Jewett's) have many superiorities over the others in that they pass across the fracture line and also are anchored to the shaft of the femur with

screws. Their insertion is more difficult and a longer incision is required, but these disadvantages are outweighed by the nearly perfect fixation which can be secured.

In any method of internal fixation of fractures of the hip, nothing is gained by early ambulation. Frequent change of position in bed and freedom of movement of the legs are sufficient exercise to prevent hypostatic pneumonia or pressure ulcers. The recent work of Urist demonstrates plainly that overstrain of a healing fractured hip may easily damage developing blood vessels and lead to late destructive changes in the femoral head. On the other hand, if a patient is kept in bed for at least eight weeks after the operation, there is far less danger of circulatory injury at the fracture site.

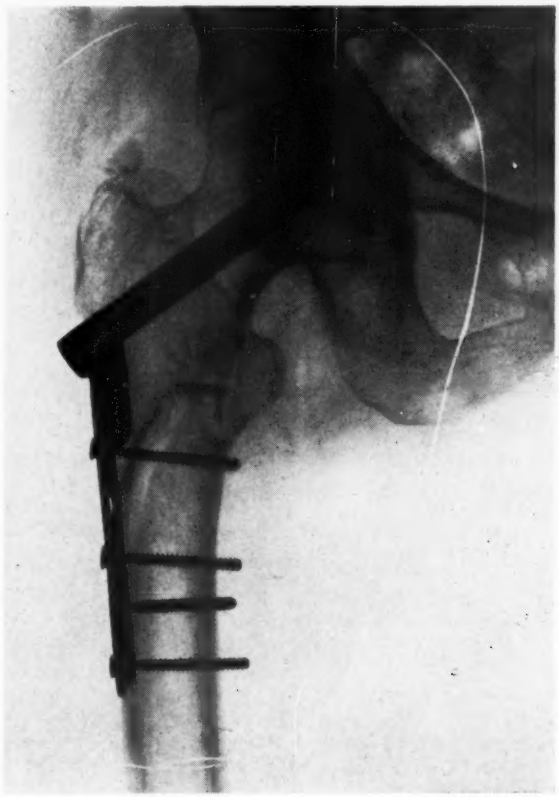

Fig. 16.—Jewett angle nail supporting a comminuted pertrochanteric fracture in normal position.

In the 65 cases of intertrochanteric fractures before mentioned, the treatment methods listed in Table IV were used.

The most satisfactory functional results were obtained in those cases which were treated by internal fixation and the angle nails which were secured to the shaft of the femur were the most successful appliances used. There was very little postoperative pain, the patients moved

TABLE IV

TREATMENT METHODS	NO. OF CASES
Traction in Thomas splint	16
Jewett or Neufeld angle nail	15
Smith-Petersen nail	10
Two vitallium screws	9
Whitman abduction cast	8
Smith-Petersen nail with plate	7
Total	65

freely in bed, and coxa vara deformity developed in only one case in which the screws were improperly applied. This seems to be the method of choice in the patients who can safely undergo an anesthetic and an operation.

SUMMARY

1. Trochanteric fractures of the femur, while not as difficult to treat as neck fractures, present special problems which are just as worthy of attention.

2. Trochanteric fractures of the femur occur in older patients than do femoral neck fractures; they are the result of greater injury; they are attended with greater pain; and they occur more often in the right hip in males.

3. There is great diversity in the types of trochanteric fractures so that generalizations about symptoms, deformities, and treatment are seldom accurate.

4. Treatment of trochanteric fractures follows several lines: use of external splints, traction devices, or internal fixation. The relative advantages and disadvantages of each method are discussed in relation to a modern plan of treating these fractures.

5. Present-day internal fixation of trochanteric fractures offers patients greater comfort, less disability, shorter hospitalization, and less likelihood of severe systemic complications from the enforced bed rest.

REFERENCES

1. Anderson, R.: A New Method for Treating Fractures Utilizing the Well Leg for Countertraction, Surg., Gynec. & Obst. **54**: 207, 1932.
2. Anderson, R., McKibbin, W. B., and Burgess, E.: Intertrochanteric Fractures: Nonoperative Castless and Ambulatory Method of Treatment, J. Bone & Joint Surg. **25**: 153, 1943.
3. Brewster, W. R.: Fractures of the Upper Extremity of the Femur—Neck and Trochanter, Am. J. Surg. **42**: 662, 1938.
4. Caldwell, J. A.: Subtrochanteric Fractures of the Femur, Am. J. Surg. **59**: 370, 1943.
5. Casberg, M. A.: Use of the Lag Screw for Internal Fixation of Intertrochanteric Fractures of the Femur, Surg., Gynec. & Obst. **72**: 772, 1941.
6. Cleary, E. W., and Morrison, G. M.: Lock-Bolt Fixation of Fractures of the Femoral Neck and of Intertrochanteric Fractures, J. Bone & Joint Surg. **22**: 125, 1940.
7. Compere, E. L., and Banks, S. W.: Pictorial Handbook of Fracture Treatment, Chicago, 1943, The Year Book Publishers, Inc.
8. Cordasco, P.: Evolution of Treatment of Fracture of Neck of Femur, Arch. Surg. **37**: 871, 1938.

9. Druitt, R.: The Principles and Practice of Modern Surgery, Philadelphia, 1852, Blanchard & Lea.
10. Dunlop, J.: The Russel Traction Method of Treating Fractures of the Femur, Am. J. Surg. **49**: 155, 1940.
11. Hodgen, J. T.: On Fractures, M. & S. J. **8**: 228, 1871.
12. Jewett, E. L.: One Piece Angle Nail for Trochanteric Fractures, J. Bone & Joint Surg. **23**: 803, 1941.
13. Jones, C. P.: Intracapsular and Intertrochanteric Fractures of the Femur and Fractures of the Pelvis—Their Treatment, California and West. Med. **36**: 79, 1932.
14. Key, J. A.: Internal Fixation of Trochanteric Fractures of the Femur, SURGERY **1**: 13, 1939.
15. Leydig, S. M.: Trochanteric Fractures of the Femur, J. Missouri M. A. **36**: 413, 1939.
16. Leydig, S. M., and Brookes, T. P.: Treatment of Pertrochanteric Fracture of the Femur With a Lag Bolt, J. Missouri M. A. **37**: 354, 1940.
17. Lippman, R. K.: The Role of Internal Fixation With the Corkscrew Bolt in Intertrochanteric Fractures, J. Mt. Sinai Hosp. **7**: 459, 1941.
18. Martin, E. D., and King, A. C.: Preliminary Report of a New Method of Treating Fractures of the Neck of the Femur, New Orleans M. & S. J. **75**: 710, 1922.
19. Moore, A. T.: Fracture of the Hip Joint, Surg., Gynec. & Obst. **64**: 420, 1937.
20. Moore, A. T.: Personal Communication.
21. Moore, A. T.: Blade Plate Internal Fixation for Intertrochanteric Fractures. (In Press.)
22. Morris, H. D.: Trochanteric Fractures, South. M. J. **34**: 571, 1941.
23. McKibbin, W. B.: Trochanteric Fractures of the Femur, Northwest Med. **40**: 242, 1941.
24. McKibbin, W. B.: An Ambulatory Method of Treatment for Intertrochanteric Fractures of the Femur, Surg., Gynec. & Obst. **76**: 343, 1943.
25. Overton, L. M.: Personal Communication.
26. Preston, M. E.: Fractures and Dislocations, St. Louis, 1915, The C. V. Mosby Co.
27. Russell, R. H.: Theory and Method in Extension of the Thigh, Brit. M. J. **2**: 637, 1921.
28. Stimson, L. A.: A Practical Treatise on Fractures and Dislocations, New York, 1910, Lea & Febiger.
29. Thatcher, H. V.: An Internal Fixation Device for the Treatment of Intertrochanteric Fractures of the Femur, Am. J. Surg. **60**: 44, 1943.
30. Thornton, L.: The Treatment of Trochanteric Fractures: Two New Methods, Piedmont Hosp. Bull. **10**: 21, 1937.
31. Thornton, L.: Personal Communication.
32. Urist, M.: Personal Communication.
33. Venable, C. S., and Stuck, W. G.: Vitallium Nails in Fracture of the Hip, Surg., Gynec., & Obst. **70**: 964, 1940.
34. Wendel, A.: Extracapsular Fractures of the Femur in the Aged: Merits of the Russell Treatment, J. Bone & Joint Surg. **13**: 616, 1931.
35. Wilkie, D. P. D.: The Treatment of Fracture of the Neck of the Femur, Surg., Gynec. & Obst. **44**: 529, 1927.
36. Wilson, P. D.: Management of Fractures and Dislocations, Philadelphia, 1940, J. B. Lippincott Company.

HEPATOMA IN INFANCY AND CHILDHOOD

Discussion and Report of Patient Treated by Operation

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REPORTS of primary tumors of the liver in children have appeared in the literature, although infrequently. Most of these are autopsy reports. The surgical removal of liver tumors has also been recorded a number of times, although most of these removals have been in adults. When, during the course of an exploratory laparotomy in a 13-month-old baby, a huge tumor was found imbedded in the liver, the question immediately arose as to the feasibility of removal. The report of this case and the review of similar cases in the literature would seem to be of some value in future decisions.

CASE REPORT

C. E. L., male, aged 13 months (Children's Hospital No. 41-8173), was admitted Dec. 24, 1941. The following history was obtained from the mother. The patient was the first and only child. He was said to be a "blue baby" at birth with typical resuscitation. Birth was at full term, weight 7½ pounds. He was jaundiced immediately post partum and remained so for two or three weeks. He was well after this until July 1, 1941, when he developed whooping cough. Prior to onset of the cough he weighed approximately 20 pounds. He started losing weight immediately. His skin became pasty and by August, 1941, he weighed about 14 pounds. That same month the parents noticed a mass in the upper abdomen on the right side, about the size of an egg. The mass, except for some recessions, grew steadily. He was constipated after the onset of the whooping cough. No jaundice was noticed since three weeks after birth. A low-grade fever was suspected for months.

On admission the baby was thin and sallow. He had a temperature of 100.4° F. Weight was 15 pounds. The anterior fontanel was open and all sutures were separated. The left eardrum was injected and bulging, the right showed evidence of spontaneous rupture. There was a nasal discharge. One tooth was present. Heart showed possibly a slight enlargement with a short loud systolic murmur. Lungs were entirely clear. The abdomen was soft and the liver edge was felt about 3 cm. below the costal margin. A rounded firm mass filled the right side of the abdomen and extended to the flank and iliac crest. It could not be determined whether the liver edge overlapped this mass or merged with it. The mass moved with the liver.

Blood showed 65 per cent hemoglobin; 3,620,000 red corpuscles with 4 nucleated cells per 100; 12,600 white blood cells with 62 per cent polynuclears; coagulation time was three minutes. Urine was not remarkable.

A flat plate of the abdomen showed a mass on the right without definite outline of the right kidney (Fig. 1). Barium enema was negative except for a very low

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hepatic flexure and pressure signs on the cecum with displacement to the left (Fig. 2). After diodrast compound was given intravenously, no abnormality could be found in the left kidney although filling was not complete. While filling of the right kidney calyces and ureter was only partial, there was no definite evidence of abnormality.

A transfusion of 100 c.c. of blood was given December 31. On Jan. 2, 1942, exploratory laparotomy revealed a large rounded tumor protruding from, but deeply embedded in, the right lobe of the liver. It was of firm consistency and covered with large blood vessels. Search of the rest of the abdomen revealed no other tumor. The liver tumor was roughly encapsulated and could be peeled out of the liver, but with profuse bleeding which was controlled by deep encircling sutures and a rubber dam-covered gauze pack. A transfusion of 50 c.c. of blood was added that day and another of 100 c.c. two days later.

Fig. 1.—Flat plate of abdomen before operation, showing shadow of tumor and displacement of intestine.

Convalescence was satisfactory until seven days later, when a moist wound followed by protrusion of omentum occurred. From then on, for two weeks, the condition of the child was not good, there were signs of sepsis, and it was not until February 15, that the child was dismissed from the hospital. He was then in good condition and gaining rapidly.

Reports obtained from the parents from time to time showed normal growth and progress. In April, 1943, he visited the hospital at the request of the social service. He was well nourished and looked healthy, his weight was 30 pounds, his incisional scar was solid, and the liver could be felt well below the costal margin. X-ray no longer showed the low position of the hepatic flexure. (Fig. 3.)

Unfortunately, no photograph was taken of this child before operation. A photograph one week after operation and one in April, 1943, show his progress (Figs. 4 and 5).

Pathologic report by the Children's Hospital pathologist, Dr. E. I. Dobos, is as follows:

Gross Description.—The tissue specimen consisted of a very large, completely encapsulated, globular shaped tumor mass measuring 9½ cm. in diameter. The weight was 452 Gm. The capsule was thin, but continued uninterrupted. On cross section, the tumor mass presented a somewhat heterogeneous appearance. There were several nodular masses on the cut surface and the entire tumor was composed of concentrically arranged masses in several places containing a large amount of biliary pigmentation. The color varied from light brownish red to light yellowish gray color.

Fig. 2.—Barium enema before operation, showing downward displacement of hepatic flexure.

Microscopic Examination of the tissue specimen showed a preponderance of uniform cells resembling liver cells with fatty degeneration in their appearance. The nuclei were situated eccentrically, which was due to the deposition of fatty substances in the cytoplasm. The nuclei showed slight degree of variation in size and architecture. In the same section, however, there were a few small areas which were composed of cells that are a great deal more compact, which contain no fatty granules in the cytoplasm, and the cells are a great deal more crowded. Neither in these areas nor the previously described areas, where the fatty cells existed, was there any evidence of trabeculation as one would expect in the liver parenchyma. The smaller more compact nodules exhibited some significant histologic changes, namely, the cells became a great deal more polymorphic; some extremely large cells were

scattered through these areas with distinctly atypical chromatin architecture and there were a large number of mitotic figures and every evidence of anaplasia on the part of these tumor cells. The blood vessel walls, however, are not infiltrated by the tumor cells and in the perivascular spaces in the adventitial layer, leukocytes, and round cells were found.

Diagnosis.—Solitary hepatoma of the liver with distinct malignant changes (Figs. 6, 7, and 8).

A later examination of this specimen was made by Dr. W. C. Black of the department of pathology of the University of Colorado Medical School. His microscopic description is similar but he does not consider the tumor a malignant one. His description follows:

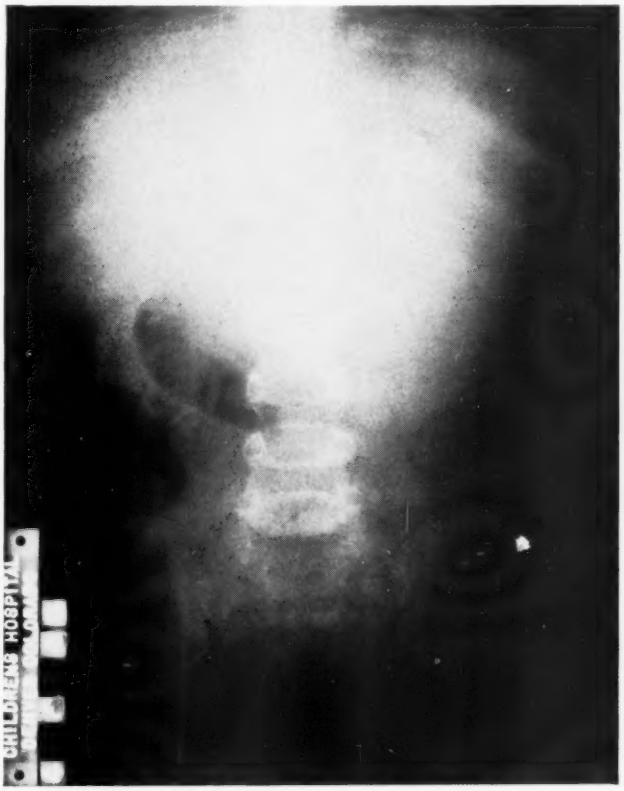

Fig. 3.—Flat plate of abdomen sixteen months after operation showing return of hepatic flexure of colon to normal position.

Gross Description.—The specimen had been fixed in formaldehyde solution. It was a spheroidal tumor measuring 8 by 10.5 by 7.5 cm. It was fully enclosed by a fibrous capsule 0.1 to 0.2 cm. in thickness. The tumor had been almost completely bisected. The cut surfaces thus exposed were solid, pale gray, with a few linear green markings dividing the tumor into coarse lobules. The substance was friable, having about the same consistency as formalin fixed liver.

Microscopic Description.—The capsule was composed of fibrous tissue, contained blood vessels and lymphatics and was continuous with septa which carried small epithelial lined ducts and divided the tumor into large irregularly formed lobules. The lobules consisted of cords of large polyhedral cells resembling liver cells, separated by compressed and almost empty sinusoidal capillaries. The tumor cells in

some areas had a clear faintly reticular cytoplasm, while in others the cytoplasm was granular, slightly eosinophilic. Empty intracytoplasmic vacuoles suggesting fatty metamorphosis appeared in many cells. Mitotic nuclear divisions were present but not numerous. Central veins and portal radicles were identifiable but did not bear a constant relationship to each other. The number of small ducts was larger than in the normal liver, and their arrangement was less uniform. The green streaks noted grossly represent some of these ducts which contain bile pigment, although none appeared in the tumor cells or in the larger bile ducts.

Pathologic Diagnosis.—Liver cell adenoma (hepatoma).

Fig. 4.—Photograph of patient four weeks after operation; general weight appearance about as before operation.

Ewing[1] discusses primary epithelial tumors of the liver in some detail. He classifies them as (1) hepatoma, under which heading he puts (a) solitary adenoma or solitary hepatoma, (b) primary massive liver cell carcinoma, (c) multiple liver cell carcinoma or hepatoma, and (d) carcinomatous cirrhosis or multiple adenoma, carcinoma, or hepatoma; and (2) cholangioma or tumors of the bile ducts. The tumor here reported apparently comes under the head of (1a) solitary adenoma or hepatoma. Many of these, Ewing states, appear in early life, from 3 months of age or later, and are therefore probably to be regarded as

of congenital origin. He adds that a congenital maladjustment of groups of liver cells predisposing them to tumor growth, although a rare factor in adults, is possibly of importance in infants with solitary tumors.

Ewing's description of a projecting and encapsulated tumor, gray to yellow, composed of cords in arrangement closely resembling liver structure, granular cells, and some fatty, the veins not invaded, corresponds closely to the findings in this case. He considers that while the veins are not invaded, the benign character is due chiefly to the encapsulation and that transitional forms to adenocarcinoma occur in which there are invasion of veins and multiplication of tumors. He regards the process as essentially carcinomatous.

Fig. 5.—Photograph of patient sixteen months after removal of hepatoma.

Survey of the literature does not in many cases give a clear distinction between benign and malignant hepatoma. In 1918, Griffith[2] collected from the literature 57 cases of what he considered primary carcinoma of the liver in infants and children. In only one was removal attempted, and that unsuccessfully. Dansie,[3] in his report of a case in 1922 found 23 cases of primary growth of the liver up to 2½ years, most of these being in the first six months. No cures were noted.

Shaw,[4] in 1923, reported the successful removal of a 2 pound 3 ounce tumor from the liver of a boy 13 years of age. He considered his case a hepatoma and described his tumor as an encapsulated liver cell tumor with aberrant character of cells pointing to a certain, but not high, degree of malignancy. He felt that this case, like many others, represented a stage of transformation of a simple adenoma to a definitely carcinomatous liver tumor. If such a case is allowed to go on he believes there will be secondary nodules in the liver itself and in time gross tumor thrombi in the portal vein and hepatic veins with metastases beyond.

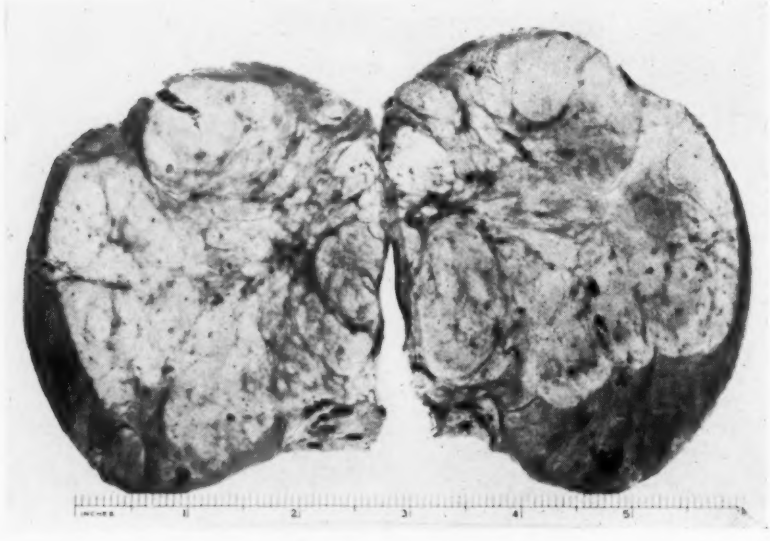

Fig. 6.—Gross appearance of tumor.

Kilfoy and Terry,[5] in 1929, commented on the rarity of primary liver cell tumor in early life and could find only 44 cases in patients between the ages of 1 day and 16 years sufficiently authenticated to include in their report. Their own case showed a solid carcinoma 6 cm. across consisting of groups of polygonal or spherical cells in a dense connective tissue framework without gland or duct formation, and separated in general from the liver by bands of connective tissue. There were retroperitoneal and lung metastases.

Three cases in early life of primary liver tumor consisting of polyhedral to spherical cells in general liver arrangement were reported by Pirie,[6] in 1932. All were considered primary carcinomas of the liver. One patient, aged 8 months, died without operation, another, aged 8 months, died after exploration with biopsy, and a third, aged 11 years, who survived the removal of a pedunculated mass weighing 220 Gm. was living and well two years later. This tumor had obviously not extended beyond its encapsulation.

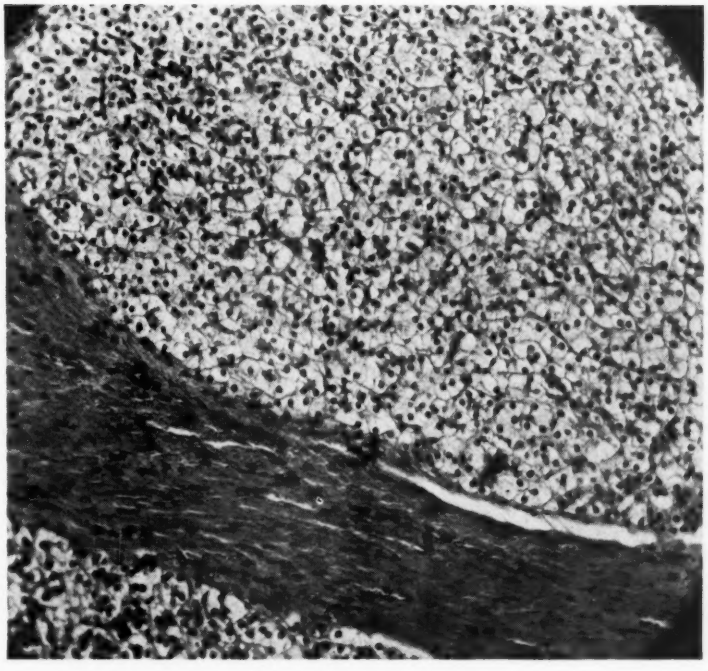

Fig. 7.—Section of the hepatoma showing a fibrous septum and solid masses of tumor cells with clear cytoplasm (×125).

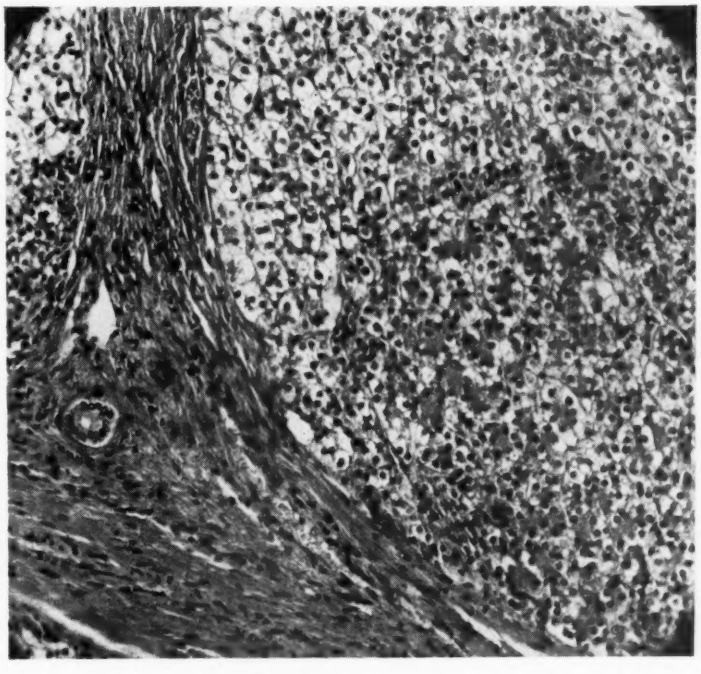

Fig. 8.—Section showing a septum and bile duct. Some of the adjoining tumor cells have granular cytoplasm (×125).

An infant of 11 months was seen by Kordenat.[7] On exploration a large irremovable liver tumor was found and needled. The baby died the following day, apparently of hemorrhage. At autopsy a tumor of a liver cell type weighing 1,120 Gm. was found. Ducas and Albot[8] discussed the symptoms and types of infantile liver tumors with their autopsy report of an infant who had multiple liver tumors and ascites. Surgical treatment was not considered as of importance.

An infant of 6 months, reported by Hagaman,[9] in 1934, died the day following the puncture of a liver tumor. Autopsy showed a tumor mass 13 cm. across, encapsulated with a narrow rim of parenchyma outside. This tumor was soft, greenish-gray and consisted of cells arranged in a liver architecture. There was a metastasis in the lung of the same character.

In 1938, Steiner[10] gave a review of the literature of primary carcinoma of the liver in childhood and reported two cases of his own. Of the 105 cases previously reported in patients under 16 years of age, he considered that 75 presented definite evidence justifying the diagnosis. One of these cases (Noeggerath[11]) was found at birth. He stated that the average duration of life after the onset of symptoms was four months, and found no recovery. Surgery was done in 4 cases, but none was successful. In this series reported, the distinction between the different grades of hepatoma is not made clear.

In a description of an orange-sized liver tumor which came to autopsy after exploratory laparotomy, Wilens,[12] in 1938, discussed, as have some others, the strong resemblance of the picture of hepatoma to that of adenoma of the cortex of the adrenal.

Charache,[13] while not discussing in particular the problem of liver tumor in infancy and childhood, has gone over a huge number of reports and has found 1,125 cases of primary liver carcinoma up to August, 1937. He stated that the average duration of life after onset of primary epithelial tumor is three months and that the treatment is exclusively surgical. His patient died two days after operation.

The successful removal of a solitary adenoma of the liver in an infant 7 months of age was reported by Benson and Penberthy,[14] in 1942. They considered the tumor a hamartoma. The mass contained imperfectly formed liver lobules, biliary ducts, and blood vessel networks in purposeless arrangement. This case is included in hepatoma consideration as it may perhaps come under the heading of adenomas as described in other reports.

Cases have been reported showing the difficulty of differential diagnosis from Wilms' tumor,[15] showing spontaneous intraperitoneal hemorrhage,[16, 17] showing Banti's syndrome as the presenting symptom,[18] and showing various types of extension and metastasis.

Perusal of the articles on primary liver cell tumors leaves the reader confused on the question of malignancy. Bile duct tumors which rep-

resent a definite type of tumor as contrasted with the tumor of liver cells are not being considered. The use of the term carcinoma rather loosely to describe all hepatomas that have any aberrant cells, clouds the picture of prognosis and treatment. In the case here reported the two pathologic reports were at variance as to malignancy.

The consensus in the articles covered seems somewhat as follows. Adenoma of the liver may be single or multiple. It is defined as a seemingly benign neoplasm of the hepatic parenchyma arising chiefly from liver cord cells. This tumor has been named hepatoma, although the same expression has been used to include many other tumors, some frankly carcinomatous. There are many reasons to think they may be of congenital origin. Congenital hepatic inclusions or rests may represent segments separated during fetal life from the main liver and subsequently become embedded in the liver (Rolleston[19]). Ewing,[1] as already stated, considers the congenital origin seriously. Adenomas have been found in nurslings[20] and primary carcinoma of the liver has been reported at birth.[11]

A typical adenoma or so-called benign hepatoma is usually single but may be multiple, may be small or large, is yellowish brown or yellowish red, is soft or hard, encapsulated. It mimics the pattern of a liver nodule showing strands of polyhedral cells which, however, are not regularly arranged about a central vein as in a normal hepatic nodule. The cells are granular and acidophilic; they may be fatty. Mitotic figures are often seen. The whole makes up a network of capillaries and convoluted liver cells.[21] In the typical form the veins are not invaded and the benign nature is due to the capsule. Growth is slow; there may develop areas of cystic degeneration, hemorrhage which may break into the general peritoneal cavity, or calcification. While these tumors may grow slowly for years, apparently the benign ones may become malignant and metastasize through the hepatic vessels. Transitional forms are distinguished by vein invasion, gradual progression beyond the capsule, and later multiple tumors or metastases. Patients who had removal of "benign" encapsulated hepatomas have returned with metastases. A typical one is that reported by Glenn and Byrne.[22] The malignant potentiality has been stressed by most writers.[10, 21, 23, 24, 25]

Symptoms are not diagnostic unless the tumor is large enough for mechanical pressure. They usually consist of mild indigestion or disturbance caused by the size and weight of the tumor. Pressure on the stomach or kidneys more commonly directs attention to those organs. Liver function tests are not valuable because that organ will do full function in spite of pressure. While liver tumor is more common in older persons, enough early age cases have been reported to warrant, as Steiner[10] says, a consideration of primary neoplasm in differentiation of enlargements of the liver in childhood.

Treatment is based on pressure symptoms and malignant possibilities. It may be that many small tumors remain so throughout life and are never found. Spreading and metastasizing tumors are very seldom removable. As all these hepatomas, no matter how benign appearing, are potentially malignant, they should be removed, preferably with a margin of liver tissue.[24] The treatment is exclusively surgical. The risk of surgery naturally depends upon the size and extent of the tumor. Wallace,[24] for example, found 29 patients with resectable hepatoma, of which 23 survived operation. Eight of the 20 had a recurrence. Twelve are known to be alive and well, two to five years after operation.

The surgical removal of liver tumor is often dismissed as not feasible, but an astonishingly large number of successful operations have been reported. No attempt will be made to cover them all, but some illustrating the various techniques will be mentioned. As far back as 1899, Keen[26] reported his third case of removal of a liver tumor. Two of the tumors, an adenoma and a carcinoma, were removed with the cautery, the larger vessels tied, and a gauze packing inserted, while the other, an angioma, was brought out extraperitoneally, constricted by an elastic ligature, and allowed to slough away. To go with his case report, Cushing and Downs added for him a table of 75 cases of liver tumor removal found in the literature up to that date. These showed a mortality of 14.9 per cent, gave ages from 2½ days to 77 years, and included herniated lobe, syphiloma, carcinoma, adenoma, sarcoma, angioma, hydatid cyst, and others more rare.

Yeomans,[27] in 1915, reported the removal of a carcinoma of the liver by curettage without evidence of recurrence for seven years. Grey Turner,[28] in 1923, reported the removal of a large tumor from the right lobe of the liver. Interlocking heavy catgut sutures on large fully curved intestinal needles were placed preceding the V-shaped resection. Some hepatic artery branches were also tied. The sides of the V could then be approximated by four through-and-through catgut sutures. One area not quite closed was packed with rubber-protected gauze. This tumor was a true liver cell tumor, a hepatic adenoma with cells more aberrant than usually found. When seen twenty-two months later, the patient appeared well.

Wright,[25] in 1923, reported the successful removal of a tumor the size of an orange with a small neighboring nodule from the liver of a man 60 years of age. The pathologic report showed primary carcinoma of the liver; there was an excellent capsule except at a few places. He advised the shelling out or bold cutting of the liver without the preliminary placing of interlocking sutures, the use of a hot pack, and then the picking up of individual vessels. He was unable to approximate the edges in this case and used a gauze pack.

A malignant tumor of the gall bladder infiltrating the liver was reported by Frankan,[29] in 1923. He removed with scalpel the gall blad-

der, a wedge of liver 3 inches wide at the base, 3½ inches deep, and over 2 inches thick at the deepest part of the incision. As sutures did not stop the brisk hemorrhage, he brought up a large fold of great omentum in a double layer which he inserted into the liver incision. Sutures were then passed through the omentum and liver with good coaptation of the cut edges and gave complete hemostasis. That part of the omentum was then cut off. He has used omentum in other cases of torn or cut liver and found this hemostatic method most satisfactory. His patient when last seen, 15 months after operation, was doing well.

Philip Turner[30] removed with the cautery an adenoma of the liver which had previously ruptured and was still bleeding, but his patient died one hour later. Kidd,[31] at the same meeting, reported the wedge removal of an adenoma after first placing sutures with Cullen's blunt needles. In the discussion of this case, Walton[31] described his method. An assistant should evert the liver and strongly grasp it on either side with his hands. With the hemorrhage thus under control, the tumor may be removed partly by excision, partly by enucleation. He then uses wide mattress sutures of large catgut through either side to grasp the liver tightly. When tied, the gaps in the approximation may be closed by additional sutures passed under the loops of the mattress sutures, the combination controlling the hemorrhage completely.

Nitch,[32] in 1923, removed a tumor of the lingual lobe. The area was clamped, resected, and then closed with mattress sutures. Hicks,[33] in 1929, reported the successful removal of a carcinoma of the liver in a man 77 years of age, using sharp dissection and sewing the gap as cut with interlocking catgut sutures, then employing a rubber glove for tamponage and drainage. The removal of a large pedicled adenoma by Schrager,[21] reported in 1937, represents the occasional type not requiring special methods of hemostasis.

Abel,[34] in 1933, reported the removal of most of the left lobe of the liver for a large primary carcinoma. He placed chain ligatures before removal, with some ties afterwards. Love,[35] in 1934, reported the removal of the whole left lobe after finding the pedicle and tying the hepatic artery and portal vein branches. The mass was the size of a cocoanut, which was later diagnosed hepatoma. Death from metastases occurred two months later. Jackson[36] had previously reported the removal of most of the left lobe after ligation of the left hepatic artery and the corresponding veins. His patient, aged 80 years was well seventeen months later.

Cattell,[37] in 1940, in his reported removal of a metastatic nodule from the right lobe of the liver made a large V-shaped incision to include the mass which was over three inches in diameter. The bleeding was controlled by the slow coagulating current and by separate ligatures of the larger vessels. The defect was closed by interrupted catgut sutures after freeing the left lobe to allow more mobility.

Wallace,[24] in an excellent review of the subject of hepatoma in 1941, described the removal of such a tumor from the right lobe. After a series of overlapping mattress sutures through normal liver, the tumor with the gall bladder attached was removed by a wedge-shaped incision with a sharp knife through normal tissue, the mattresses were tied, and the raw edges closed with a running suture.

Benson and Penberthy[14] accomplished their removal of a 60 Gm. tumor in a child by making a wedge-shaped excision with a cautery knife and closing this with sutures after placing omentum in the gap.

The subject of surgical technique has been quite thoroughly presented by Walton[31] and later studied by Tinker and Tinker.[38] The latter point out that the lobes and subdivisions of the liver are supplied by independent arteries so that one section can be removed without injury to the remaining sections, that anastomoses are free so that if the blood supply to a part is removed there may still be adequate circulation, and that regeneration after removal of liver substance is rapid and quite complete. Mann[39] also, in his experimental surgery, has shown the tremendous regeneration power of the liver and the technique of left lobe removal.

Methods used for liver tumor removal by the authors quoted are varied but follow a few general principles. (1) The tumor or that part of the liver may be delivered into the wound and exteriorized. Pins like knitting needles may be used to hold it in place if desired; sometimes an elastic tourniquet is used. Separation may require two weeks or so and it takes many weeks for the stump to heal over. This method has been described mostly in the earlier reports. (2) There has been wide use of a low-heat cautery or a cautery knife with tying of the larger vessels. This seems less in favor perhaps than formerly, but is probably necessary for some types. (3) First placing deep mattress sutures or interlocking sutures in normal tissues, then cutting out the wedge and tightening the already placed sutures followed by an additional running suture to close the free edge may be considered a standard method. It depends on close opposition plus mattress type of suture to control bleeding and sounds ideal for the usual large wedge resections. (4) The tight holding of the free liver edge by an assistant while the wedge is cut out and then tying individually or by through-and-through sutures is practicable for some cases. Whenever possible, permanent arrest of hemorrhage by mattresses or individual ties is the best. It is often possible to tie the branches of the hepatic artery and to encircle the large venous channels. The capsule is the only tough part of the liver that holds at all which makes some mattress type of suture usually necessary. Simple approximation takes care of the smaller wedges. If approximation cannot be accomplished, then approximation over gauze, rubber dam, or omentum must be substituted to gain hemorrhage control. If temporary clamping or holding of the main blood supply at the free edge of the lesser omentum is employed, it must be very brief as it causes

a dangerous drop in blood pressure.[38] Clamps on the liver itself are not, as a rule, satisfactory; temporary tourniquet use is not often practicable.

CONCLUSIONS

1. A case is reported of successful removal of a large hepatoma, showing some suggestions of early malignancy without evidence of recurrence after fifteen months.

2. The literature reveals that the benign adenoma or hepatoma does not by any means remain benign and may destroy by pressure if of large size or by malignant extension.

3. Treatment is exclusively surgical; the standard techniques of liver tumor removal are reviewed.

4. The experiences of various surgeons with this problem are reported.

ADDENDUM

A letter from the University of Nebraska Hospital, dated January, 1944, states that this same patient was admitted there Nov. 11, 1943, for abdominal tumors. Exploration showed a normal right lobe of the liver but a left lobe full of tumor nodules. A small piece taken from one of these nodules was diagnosed carcinoma of the liver (hepatoma type). The tissue was considered after comparison very similar to that removed here in January, 1942.

REFERENCES

1. Ewing, J.: Neoplastic Diseases, Ed. 4, Philadelphia, 1940, W. B. Saunders Company, pp. 735-748.
2. Griffith, J. P. C.: Primary Carcinoma of the Liver in Infancy and Childhood, Am. J. M. Sc. **155**: 79, 1918.
3. Dansie, C. B.: Primary Malignant Growth of Liver in Infants. Report of Recent Case, Lancet **2**: 228, 1922.
4. Shaw, A. F. B.: Primary Liver Cell Adenoma (Hepatoma), J. Path. & Bact. **26**: 475, 1923.
5. Kilfoy, E. J., and Terry, M. C.: Primary Carcinoma of the Liver in Childhood, Surg., Gynec. & Obst. **48**: 751, 1929.
6. Pirie, G. R.: Primary Carcinoma of the Liver in Infants and Young Children, Canad. M. A. J. **27**: 401, 1932.
7. Kordenat, R. A.: Primary Carcinoma of the Liver in Infancy, Am. J. Digest. Dis. **1**: 60, 1934.
8. Ducas, P., and Albot, G.: Les Epitheliomas Primitifes du Foie chez l'Enfant, Arch. de méd. d. enf. **36**: 595, 1933.
9. Hagaman, G. H.: Primary Carcinoma of the Liver. Report of a Case in a 6 Months Old Infant, Minnesota Med. **17**: 40, 1934.
10. Steiner, M. M.: Primary Carcinoma of the Liver in Childhood. Report of 2 Cases With a Critical Review of the Literature, Am. J. Dis. Child. **55**: 807, 1938.
11. Noeggerath, E. (Cited by Steiner[10]): Geburtshindernis in Folge eines Lebercarcinoms beim Neugenbornen, Deutsche klin. **6**: 496, 1854.
12. Wilens, G.: Adenoma of the Liver, Am. J. Dis. Child. **55**: 792, 1938.
13. Charache, H.: Primary Carcinoma of the Liver, Am. J. Surg. **43**: 96, 1939.
14. Benson, C. D., and Penberthy, G. C.: Surgical Excision of Primary Tumor of Liver (Hamartoma) in Infant of Seven Months With Recovery, SURGERY **12**: 881, 1942.
15. Drummond, C. H., and Tollman, J. P.: Primary Carcinoma of the Liver in a Child. Case Report, Am. J. Clin. Path. **9**: 361, 1939.
16. Webster, R.: Malignant Hepatoma in Infancy, M. J. Australia **2**: 381, 1938.
17. Jenks, A. L., Powell, L. D., and Kaump, D. H.: Primary Carcinoma of the Liver With Spontaneous Rupture, J. Iowa M. Soc. **29**: 193, 1939.

18. Wentz, V. B., and Kato, K.: Primary Carcinoma of the Liver With Banti's Syndrome, J. Pediat. **17**: 155, 1940.
19. Rolleston, H. D.: Diseases of the Liver, Gall Bladder and Bile Ducts, Philadelphia, 1905, W. B. Saunders Company.
20. Pepere, A. (Cited by Schrager[21]): Arch. per le Sc. Med. **26**: 117, 1902.
21. Schrager, V. L.: Surgical Aspects of Adenoma of the Liver, Ann. Surg. **105**: 33, 1937.
22. Glenn and Byrne (Cited by Hoffman[23]): Hepatoma With Late Dissemination, J. Missouri M. A. **30**: 142, 1933.
23. Hoffman, H. S.: Benign Hepatoma; Review of the Literature and Report of a Case, Ann. Int. Med. **17**: 130, 1942.
24. Wallace, R. H.: Resection of Liver for Hepatoma, Arch. Surg. **43**: 14, 1941.
25. Wright, G.: Primary Carcinoma of the Liver Excised by Operation, Proc. Roy. Soc. Med. **16**: 56, 1923.
26. Keen, W. W.: Report of a Case of Resection of the Liver for the Removal of a Neoplasm With a Table of 76 Cases of Resection of the Liver for Hepatic Tumors, Ann. Surg. **30**: 267, 1899.
27. Yeomans, F. C.: Primary Carcinoma of the Liver, J. A. M. A. **64**: 1301, 1915.
28. Turner, G. G.: A Case in Which an Adenoma Weighing 2 lb. 3 oz. Was Successfully Removed From the Liver: With Remarks on the Subject of Partial Hepatectomy, Proc. Roy. Soc. Med. (Dept. Surg.) **16**: 43, 1923.
29. Frankau, C.: A Case of Resection of the Liver for Malignant Disease Spreading From the Gall Bladder, Proc. Roy. Soc. Med. (Dept. Surg.) **16**: 59, 1923.
30. Turner, P.: Case of Excision of an Adenoma of the Liver Which Had Ruptured Spontaneously Causing Internal Hemorrhage, Proc. Roy. Soc. Med. (Dept. Surg.) **16**: 60, 1923.
31. Kidd, F.: Case of Primary Tumor of the Liver Removed by Operation, Proc. Roy. Soc. Med. (Dept. Surg.) **16**: 61, 1923.
32. Nitch, C. A. R. (Cited by Charache[13]): Lancet **1**: 334, 1923.
33. Hicks, E. S.: Removal of a Primary Carcinoma of the Liver, Canad. M. A. J. **20**: 169, 1929.
34. Abel, A. L.: Primary Carcinoma of the Liver With Report of Case Successfully Treated by Partial Hepatectomy, Brit. J. Surg. **21**: 684, 1933.
35. Love, R. J. McN.: Primary Carcinoma of the Liver. Successful Lobectomy, Brit. J. Surg. **22**: 387, 1934.
36. Jackson, R. H. (Cited by Charache[13]): Tr. South. S. A. **44**: 299, 1931.
37. Cattell, R. B.: Successful Removal of Liver Metastasis From a Carcinoma of Rectum, Lahey Clin. Bull. **2**: 7, 1940.
38. Tinker, M. B., and Tinker, M. B., Jr.: Resection of the Liver; Conditions Favorable for Operation; Methods; Experimental Studies, J. A. M. A. **112**: 2006, 1939.
39. Mann, F. C.: The Portal Circulation and Restoration of the Liver After Partial Removal, SURGERY **8**: 225, 1940.

COMMENTS ON ILEOCOLOSTOMY AND INTESTINAL EXCLUSION

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THE perforation of a carcinoma of the cecum after an ileocolostomy—the first operation of a two-stage procedure for the removal of the tumor—drew our attention to the problems encountered when procedures for intestinal exclusion are performed. Little has been written on this subject, although a voluminous literature deals with the technique of surgery of the large bowel. For this reason we would like to report a group of experiments and present records of several cases that illustrate some of the physiologic principles of surgery of the large intestine. It may be said that these observations are concerned primarily with lesions of the lower end of the ileum and right half of the large bowel and since these lesions may be treated either by single or by multiple-stage procedures, the conclusions arrived at may help in the proper planning of operative therapy.

During the past ten years, twenty-nine patients at the New York Hospital have been subjected to some type of operation for intestinal exclusion (exclusive of colostomy), performed during the course of treatment for malignant or nonmalignant diseases. Four of these patients had complications that are reported in detail as illustrations of important principles that we should like to emphasize.

Fifty years ago much thought was given to the methods of intestinal exclusion and Senn,[1] and later Hartman,[2] reported a series of experiments on so-called physiologic exclusion in which its value in the end treatment of certain types of intestinal obstruction was emphasized. With the progress of surgery, methods of exclusion have been replaced by methods of removal and, as a result, little has been written in the past forty years on principles of intestinal exclusion. However, in the present accepted methods of treatment, physiologic exclusion frequently is performed as one part of a multiple-stage procedure, or as a palliative operation, in spite of the fact that one-stage removal of right-sided lesions is becoming the custom and has been made safer with the use of the sulfonamides and such adjunct measures as the Miller-Abbott tube.

A multiple-stage removal of a right-sided lesion in the large bowel is indicated when (1) complete obstruction is present (a very rare occurrence), (2) when the lesion is fixed as a result of associated infection,

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and (3) when a patient's general condition is so poor, usually as the result of partial obstruction, that a complete, single-stage operation is too hazardous. This multiple-stage removal generally consists of an initial ileocolostomy followed, usually within two to four weeks, by the removal of the lower four to six inches of ileum, ascending colon, and hepatic flexure. Our studies are limited to the problem of planning the first stage.

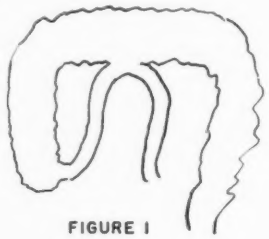

FIGURE 1

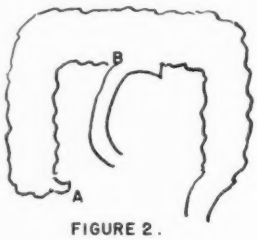

FIGURE 2.

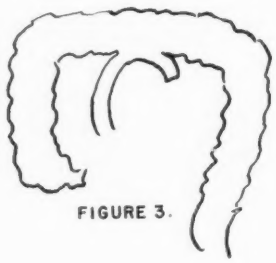

FIGURE 3.

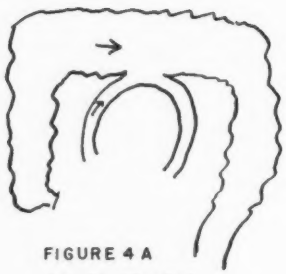

FIGURE 4 A
ISOPERISTALTIC

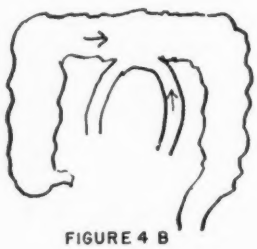

FIGURE 4 B
ANTIPERISTALTIC

Figs. 1 to 4.—Diagram illustrating three types of ileocolostomy (Figs. 1 to 3) and two types of anastomosis (Fig. 4 *A* and *B*).

In performing the original ileocolostomy one question arises: whether it should be done in continuity (Fig. 1) or whether the ileum should be divided (Fig. 2). Although opinion varies as to which is preferable, all our studies show that it is important to divide the ileum. First, division of the ileum completely diverts the fecal stream, insuring maximum rest to the bowel and lesion so that infection may subside, thus facilitating the subsequent removal. Failure to divert the fecal stream may lead to perforation of the tumor between stages, a complication that not only leads to technical difficulty in the second stage, but also may prevent completion of treatment. This is illustrated by the following cases.

W., a 39-year-old white man, was admitted to the hospital because of a palpable tumor in the right lower quadrant of six months' duration, and abdominal cramps and vomiting of two days' duration.

Examination revealed a pale, undernourished man whose abdomen was slightly distended. A tender, palpable mass was present in the right lower quadrant. Hemoglobin was 68 per cent; red blood cells, 4.6 million; white blood cells, 6,800. The diagnosis was carcinoma of the cecum.

After three days of supportive therapy, an ileocolostomy in continuity (Fig. 1) was done. The postoperative course was uneventful until the fifteenth day, when fever developed and rose progressively over the next ten days. Four weeks after the ileocolostomy, the second stage was done with great difficulty because of the presence of a large abscess at the site of perforation of the tumor. The postoperative course was stormy and complicated by a fecal fistula. Recovery was slow but complete.

The failure to divide the ileum in this patient probably prevented subsidence of infection of the tumor and led to subsequent perforation and abscess formation. Although the patient recovered, the removal of the tumor was done with difficulty and was followed by a stormy postoperative course and temporary fecal fistula.

C., a 52-year-old man, was admitted to the hospital because of weakness and fatigue of seven months' duration, and a mass in the right lower quadrant of the abdomen of two weeks' duration. There had been a loss of ten pounds in weight and intermittent diarrhea.

The patient was pale and undernourished. There was a hard, slightly tender mass in the right lower quadrant. Hemoglobin was 88 per cent; red blood cells, 3.5 million; white blood cells, 10,000. The diagnosis was carcinoma of the cecum.

After two weeks of supportive therapy, an ileocolostomy in continuity (Fig. 1) was done. The postoperative course was complicated by a mild fever during the first five days. On the eighth postoperative day the patient developed abdominal pain and high fever and after a rapidly progressive downhill course, died on the twelfth postoperative day. Post-mortem examination revealed a perforated carcinoma of the cecum with generalized peritonitis.

Failure to divide the ileum and divert the fecal stream again probably led to perforation and to the death of the patient.

Another advantage gained by dividing the ileum at the initial operation is the simplification of the second stage, since, not only has division of the ileum (a necessary step after ileocolostomy in continuity) been accomplished, but also the operative procedure can be completed without disturbing the previously made ileocolostomy.

The objection raised to division of the ileum is that the distal end of the divided ileum (Fig. 2*A*) may open, resulting in peritonitis. Our experience both clinically and experimentally disproves this objection. There were nine patients who had ileocolostomy with division of the ileum (Fig. 2) without complication, in contrast to thirteen patients with ileocolostomy in continuity (Fig. 1), with two complications as detailed previously. In eight animals an ileocolostomy was done as shown in Fig. 2. The distal segment of ileum and right half of the large bowel (*A* to *B*) became shrunken and atrophic. The animals were asymptomatic.

In the rare patient with complete obstruction, the ileum should be divided and the distal end may be brought up through the abdominal wall as a safety vent. However, a safety vent rarely is necessary, even with complete obstruction, and has the objection of adding technical difficulties to the second stage.

We should like to comment briefly on the technical management of the stump of ileum at the site of the ileocolostomy. As has been emphasized before, it is important that no ileum be allowed to remain distal to the anastomosis, since such an ileal pouch may perforate or become gradually distended to a size that produces symptoms of indigestion, abdominal pain, and distension. Our experiments merely corroborate this accepted fact. The following summary of a patient's record illustrates a complication that may occur when excessive ileum remains at the site of the ileocolostomy.

K., a 50-year-old white woman, was admitted to the hospital in March, 1935. In 1913, the patient had had the right half of the colon removed and an ileocolostomy performed for an obstructing lesion of the ascending colon.

For the past ten years the patient had had vague abdominal pain associated with occasional bouts of diarrhea.

For six months before admission, abdominal pain had been more or less constant, diarrhea had been frequent, and there had been loss of both weight and strength.

Except for marked pallor the general examination was negative. The abdomen was distended and visible peristalsis was present. Hemoglobin was 40 per cent; white blood cells, 8,000; red blood cells, 217 million.

A gastrointestinal roentgen series revealed partial intestinal obstruction in the region of the terminal ileum.

At operation a distended, blind pouch of ileum, measuring ten inches in length, was found at the site of the previous ileocolostomy. Simple removal of this pouch resulted in a complete cure. The patient was asymptomatic and the blood picture was normal two years postoperatively.

At times there is a question as to the type of palliative procedure that should be used for inoperable lesions of the right half of the colon. Probably, ileocolostomy in continuity is the procedure of choice, since in some cases the lesion may eventually completely obstruct the large bowel.

There has been some difference of opinion as to whether an ileocolostomy should be performed in iso- or antiperistaltic fashion. It was found that if the ileocolostomy was done in isoperistaltic fashion (Fig. 4*A*) the distal segment of ileum was less likely to fill with an accumulation of intestinal contents, and generally dogs in these experiments fared better than when they were subjected to an antiperistaltic anastomosis (Fig. 4*B*).

On rare occasions it is necessary to leave a segment of large bowel distal to a colostomy. Whereas a blind segment of small bowel distal to an ileocolostomy may be well tolerated for a limited period of time, this is not true of the large bowel. If it is necessary to leave a segment of large bowel distal to a colostomy, it is wiser to bring the end up through

the abdominal wall as a second colostomy opening or to bury the sutured distal end in the abdominal wall as added protection to the suture line. The following case illustrates what may happen if a closed segment of bowel is left distal to a colostomy.

O., a 51-year-old man, was admitted to the hospital because of symptoms and signs of partial obstruction of the lower large bowel.

Examination was not remarkable except for distention of the abdomen. A right transverse colostomy was performed and the patient prepared for resection of an obstructive lesion in the descending colon, demonstrated by barium enema.

At operation a large lesion of the descending colon was removed and, because of the extent of the lesion, so much of the bowel was resected that the proximal descending colon was not long enough to be sutured to the sigmoid. Accordingly, both ends of bowel were closed with the thought that at a later stage a reconstructive procedure would be done to re-establish the continuity of the bowel.

The postoperative course was uneventful until the fourth day, when suddenly the patient's condition became poor. He died within twenty hours.

Post-mortem examination revealed that the splenic end of the bowel had literally "blown out."

SUMMARY

1. Physiologic principles of exclusion procedures in surgery of the right half of the colon are discussed.

2. The importance of dividing the ileum when ileocolostomy is done as the initial procedure of a two-stage removal of a lesion of the right half of the bowel is emphasized.

3. The complication of pouch formation at the site of ileocolostomy is discussed.

REFERENCES

1. Senn, Nicholas: An Experimental Contribution to Intestinal Surgery With Special Reference to the Treatment of Intestinal Obstruction, Ann. Surg. **7**: 264, 421, 1888.
2. Hartman, Henri: Exclusion de l'intestin, Trav. de Chir. **5**: 61, 1907.

TORULA INFECTION

A Review and Report of Four Cases

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TORULA is a yeastlike organism belonging to the general class of fungi imperfecti, which multiplies by budding, does not produce ascospores, does not ferment carbohydrates, and does not produce a mycelium in tissue or culture. The organism is widely distributed in nature and has been cultivated from many plants and grasses, the bodies of numerous insects, bees' nests, pickle brine, and canned butter and milk. It is ordinarily nonpathogenic and various saprophytic or avirulent strains have been cultured from the normal skin, throat, and gastrointestinal tract of man.

It has been found pathogenic for man, involving more frequently the central nervous system and lungs, less frequently the viscera,[3, 10, 16] nasopharyngeal structures,[1, 2, 13, 15] skin,[13, 19, 21, 27, 28, 32, 34] lymph nodes,[8, 11, 18] and muscles and bones.[4] Frothingham[12] recorded the first spontaneous case in the animal kindgom in 1902; the disease being confined to the lungs of a horse. Weidman[32] observed a case of generalized torulosis in a horse. Weidman and Ratcliffe[33] reported it in one other animal, the cheetah, in which the process was generalized. Pathogenicity has been demonstrated experimentally in mice, rats, guinea pigs, rabbits, cats, and monkeys.[8, 21]

The nomenclature of yeast and yeastlike infections is loose and indefinite with attendant confusion. Names applied to the same or similar organisms causing the same disease picture are: *Cryptococcus hominis; C. histolytica; C. meningitidis, Torula histolytica.* Weidman[32] states that he has collected twenty pathogenic strains of the organism. The disease has been referred to as torulosis. European blastomycosis of Busse-Buschke and cryptococcosis.

It is thought that the portal of entry is usually through the upper respiratory passages and lungs, the organism having a special affinity for the tissues of the central nervous system. Invasion of this system by torula has been universally fatal. Zenker,[35] as early as 1861, reported a patient who died of encephalomeningitis, due to a yeastlike organism, associated with a pharyngeal exudate without skin involvement. He described small granulomas and collections of pus in the meninges and brain. Freeman accepted this as a probable case of cen-

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tral nervous system torulosis. The next authentic case was reported in 1905 by von Hansemann,[29] also in the German literature. Rusk and Farnell,[23] in 1912, recorded the first two cases in this country. The morphology of the organisms and pathology of the disease remained obscure until Stoddard and Cutler,[26] in 1916, isolated the organism by cultural methods, animal inoculations, and histologic study of sections of tissue; described the clinical characteristics and pathologic changes; collected four cases from the literature and added two of their own. They ascribed the name *T. histolytica* to the organism. Freeman[10] in 1931, in an exhaustive monograph, collected forty-three cases from the literature. Levin[16] summarized the reported cases of central nervous system torulosis in 1937, bringing the total to sixty. Recently, Binford,[3] in 1941, tabulated the cases reported since Levin's summary, making a total of seventy-five. Since then there have been isolated reports of twenty-five cases, making a total of 100 recorded cases of involvement of the central nervous system by torula.

A pathologic classification of central nervous system torulosis was made by Freeman,[9] in 1930. He divided the disease into three types: (1) A purely meningeal form, with diffuse or granulomatous meningitis; (2) a perivascular form, with small granulomas or cysts in the cortex; (3) an embolic form, with deeply placed lesions lying chiefly in the gray matter. Clinically, the cases of involvement of the central nervous system resemble tuberculous meningitis and brain tumor more frequently, with meningitis (unqualified), encephalitis, brain abscess, dementia psychosis, and dementia paralytica simulated less frequently.[3, 9, 17]

Coincident involvement of the lungs occurred in nine of Levin's sixty cases, in four of Binford's fifteen cases of central nervous system torulosis, and in one of the six cases of Reeves, Butt, and Hammack.[22] Reports of involvement of the lung alone are rare, and have been given by Sheppe[24] and Hardaway and Crawford[14] with an apparent recovery in the latter case.

Generalization of the mycotic process occurred in only twelve of the eighty-one collected cases of Freeman, Levin, Binford, and Reeves, Butt, and Hammack and is usually fatal. In association with and accessory to torula infection of the central nervous system and lungs, the disease has been reported to involve nearly all the tissues and organs of the body.

There are a few cases in the literature in which the infectious process was localized and limited to certain parts of the body, and in which the torula organisms were recovered from the lesions. Brewer and Wood,[4] in 1906, recorded the first; the case of a man with an abscess of the muscles and bone of the spine. Evacuation, curettement, and packing with formalin dressings effected a cure. McGehee and Michelson[18] reported the recovery of a patient after incision and drainage of

an inguinal abscess which extended into the pelvis. This patient also received a course of potassium iodide. Alvarez[1] reported a red torula infection of the tongue which responded to arsphenamine and quinine. Jones[15] reported a torula infection involving the palate and nasopharynx which was arrested after cauterization, x-ray therapy, and the internal administration of iodides. Gill[13] also reported several cases of localized torulosis, one an ulcerative cutaneous lesion in the preauricular region on each side of the face which yielded to currettement, x-ray, and potassium iodide; another infection involved the orbit and paranasal sinuses, was accompanied by the presence of torula histolytica in the blood stream, and recovery followed x-ray and potassium iodide therapy. The relationship of torulosis and Hodgkin's disease has been mentioned occasionally in the literature, though not nearly as frequently as the tuberculosis-Hodgkin's disease relationship. The tissue reaction in the reticulo-endothelial system to torula is not unlike that seen in Hodgkin's granuloma in some reported instances. Attention was first called to this fact by Freeman and Weidman,[11] in 1923, who reported a patient who was first seen five years prior to death with enlarged lymph glands of the neck. Excision biopsy of one of these revealed Hodgkin's disease. The neck glands regressed under x-ray therapy, but at the time of his final admission he had a large discrete mass in the right axilla. He died of cerebrospinal torulosis, confirmed at autopsy. Axillary and peripancreatic lymph nodes were greatly enlarged and were not quite typical of Hodgkin's disease, although highly suggestive.

There have been three other cases reported in which Hodgkin's disease has been diagnosed by biopsy sometime before the onset of torulosis. Cabot's[5] patient had a prior diagnosis of Hodgkin's disease before dying of a torula meningitis with involvement of the kidney, adrenal, and lungs with coincident involvement of the spleen and bronchial and retroperitoneal lymph glands with Hodgkin's disease. During the discussion of this case, Mallory stated that it was the fourth case that he had seen of coincident torula infection and Hodgkin's disease. He added that he had seen an unpublished manuscript in which approximately eighty cases of torulosis were mentioned in about twelve of which torula and Hodgkin's disease were found together. Owen,[20] in 1940, and Warvi and Rawson,[30] in 1942, reported patients with an earlier diagnosis of Hodgkin's disease dying of torulosis.

There have been single cases reported by Smith and Crawford[25] and Wile[34] in which an early diagnosis of Hodgkin's disease was made by biopsy. The patients later died of torulosis, and review of the original slides reveal torula organisms present in the biopsy material.

In 1934, Fitchett and Weidman[8] reported the case of an 18-year-old negro male, who had noticed enlarged glands bilaterally in the axilla, neck, and groins for three years. Admission to the hospital was for

swelling of the face and neck, dizziness, headache, and delirium. Excision of one of the axillary nodes revealed changes suggestive of Hodgkin's disease; yeast organisms were recovered in scrapings from the cut surface, but could not be demonstrated in the stained sections. The diagnosis of torulosis was made from spinal fluid and autopsy findings. The autopsy revealed changes similar to typical Hodgkin's disease in the superficial and peribronchial lymph nodes and a mediastinal mass showing more or less loss of architecture and reticuloendothelial hyperplasia with the presence of Dorothy Reed cells. Torulosis of the brain, meninges, kidneys, pancreas, and spleen was found. Torulae were cultured from the mediastinal mass. In comparing the histologic changes in the spleen, lymph nodes, and mediastinal mass they found the amount of reticulo-endotheliosis less in the spleen where the changes were due to torulae alone, than in the lymph nodes and mediastinal mass where the Hodgkin's characteristics were assumed.

To illustrate further the type of reaction incited in lymph nodes by the torula organisms, Watts,[31] in 1932, reported a patient dying of generalized torulosis, with cerebrospinal symptoms most marked, who had involvement of lymph nodes at the hilum of the spleen and near the common duct. Most of the nodes were completely replaced by fibrocaseous material. Tubercle-like structures with and without giant cells, scarring, extensive hyaline degeneration, and marked endothelial hypertrophy were present. Yeast fungi could not be found, but some giant cells contained spaces resembling the residues of organisms.

Sheppe[24] reported the first case of torulosis from the University of Virginia Hospital in 1924, that of a man who died of pulmonary torulosis, apparently without central nervous system involvement. In 1939, Magruder[17] reported three cases with involvement of the central nervous system in which the diagnosis was made ante mortem by culture and smear of the spinal fluid, associated with biopsy of the cerebral meninges and cortex in one case.

We wish to report four additional cases of torulosis, and to give a follow-up report on Magruder's third case.

REPORT OF CASES

CASE 1.—Mrs. E. S. (Hist. No. 60767), a white woman, aged 66 years, was admitted to the University of Virginia Hospital Sept. 10, 1936, in a semicomatose state.

The family history was pertinent to the extent that she had a son in the hospital at the time with typhoid fever. The past history was irrelevant.

Her illness began one month prior to admission to the hospital with headache, nausea, and vomiting. The symptoms had progressed with the addition of pain in the neck and back, and occasional fainting spells and chilly sensations. She had gradually become lethargic and was brought to the hospital in the semicomatose condition.

Physical examination revealed the following abnormalities: a very drowsy patient; a splotchy erythematous rash over the trunk anteriorly; a moderately stiff neck; a faint apical systolic murmur with heart size hard to determine; blood pressure

186/100, pulse rate 90 per minute, temperature 100.4° F.; absent knee jerks; suggestive bilateral Babinski; and a positive Gordon on the right.

Laboratory studies during the first two days of hospitalization were as follows. The hemaglobin was 84 per cent (Haden-Hauser), the leucocytes 8,800, and the differential count from a stained blood smear showed a normal distribution of cells. Blood Wassermann and Kahn tests were negative, the blood urea 64 mg. per 100 c.c., blood culture negative, and agglutinations with *Bacillus typhosus,* para A and B negative. The catheterized urine contained albumin, 3 plus, and microscopic examination revealed 2 to 3 white blood cells, 3 to 5 red blood cells, and an occasional granular cast. The stool specimen revealed occult blood, 3 plus. Lumbar puncture was performed and a pressure of 415 mm. of water found. The fluid was slightly cloudy, and had a slightly increased globulin content. There was a cell count of 474 cells with a predominence of polymorphonuclears. A smear and culture were negative.

A tentative diagnosis of benign lymphocytic choriomeningitis was made.

During the first week of hospitalization a lumbar puncture was done daily with a cell count as high as 650 at one time. The lymphocytes gradually superseded the polymorphonuclears and became more abundant. For a time she gradually improved and became more alert, being able to take nourishment by mouth. She could talk, answer questions, and recognize members of her family. However, she continued to run a fever with temperatures between 100 and 101° F., and the spinal fluid continued to show a varying number of cells. After a month of slight improvement, she became very drowsy and unresponsive, and would not take nourishment. During the last two months of her illness she was given nourishment by stomach tube and intravenous infusions.

Neurologic examination during this time revealed an inability to recognize objects, motor and sensory aphasia, a coarse tremor of the arms and legs, pain and temperature sensations markedly diminished, hyperactive deep reflexes, unsustained left ankle clonus, and a suggestive Babinski sign on the left side.

Spinal taps were done in the later stages every four to five days, the last one showing a cell count of 86, with a predominance of lymphocytes. At one time the spinal fluid globulin was greatly increased and the total protein 127 mg. per 100 c.c. The colloidal gold curve indicated only meningeal irritation. The spinal fluid Wassermann was negative. The blood urea was 50 mg. per 100 c.c.

She lapsed into rather deep coma during the last month, voided and defecated in bed, and, in spite of careful nursing care, developed several bed sores. She continued to run a fever, with temperatures from 100 to 102° F. The white count varied from 11,200 to 12,600. A week before death the temperature increased somewhat and ranged from 102 to 105° F. The respirations became more labored, and physical examination showed large coarse râles throughout both lungs, but there were no signs of consolidation. She expired on Dec. 7, 1936, about four months after the onset of the illness.

An autopsy revealed chronic torula meningitis; atrophy of the brain; chronic bronchitis and bronchiectasis; confluent lobular pneumonia with bronchogenic abscesses (right lower lobe); purulent thrombosis of pulmonary vessels; acute fibrinous pleurisy; extensive decubital ulcers over buttocks and ankles; edema of legs; atrophy of organs; emphysema; generalized arteriosclerosis; scarring of myocardium and kidneys; chronic cystitis; scarring of cervix with obliteration of cervical canal; chronic endometritis; hyperplasia of femoral marrow; pigmentation of the spleen and bone marrow.

The brain weighed 1,150 Gm. and on gross examination small areas of thickening of the pia-arachnoid over the surface were revealed. These areas were a few millimeters in diameter. On section of the brain no changes were seen except those of atrophy. The spinal cord appeared normal. Microscopic examination of the brain revealed a chronic cellular exudate and marked increase in connective tissue

throughout the pia-arachnoid. The cellular exudate consisted almost entirely of plasma cells, lymphocytes, monocytes, and giant cells of various sizes which contained torula. The organisms varied enormously in size and structure and usually occurred in small groups within the giant cells. They were spherical with a refractile margin and a central area which stained blue in some and red in others. None of the organisms were found in the section of the brain substance.

Comment.—This was a patient with torulosis of the central nervous system who died after an illness of four months. The diagnosis was made at autopsy, and would fall into Freeman's type I or the purely meningeal form. Repeated spinal fluid taps did not reveal the organism.

CASE 2.—R. T. (Hist. No. 145589), a white man, aged 26 years, was admitted to the University of Virginia Hospital Jan. 11, 1939, with the complaint of generalized weakness, headache, fever, loss of weight, and enlarged cervical glands.

The family, past, and marital histories were irrelevant.

The onset of illness had begun one and one-half years prior to admission with fatigue, weakness, general malaise, and anorexia. Headaches, anemia, loss of weight, night sweats, and fever had followed shortly. The temperature of 101 to 102° F. had run in cycles lasting ten days to two weeks followed by a remission of temperature with partial remission of symptoms for two to three weeks. He had received liver and iron for his anemia, and a course of sulfanilamide of 100 tablets. Chest x-rays, agglutinations for undulant fever, blood smears, and barium enema elsewhere had been negative. He had first noticed enlarged, tender glands in his neck two to three weeks prior to admission. During the course of his illness he had lost about forty-five pounds in weight.

Physical examination revealed a malnourished, pale individual with very pale mucous membranes. The posterior cervical and supraclavicular lymph glands were enlarged bilaterally, some to 2 to 3 cm. in diameter. They were freely movable, slightly soft, and mildly tender. None of the other superficial lymph glands were enlarged. The liver and spleen were just palpable beneath the costal margin. There was a soft apical systolic murmur. Peripheral reflexes were hyperactive. Blood pressure was 112/68; temperature 100.6° F., and pulse rate 92 per minute.

Laboratory studies were as follows: hemoglobin 71 per cent, red cell count 4,170,000, white cell count 5,000, with the smear showing a normal distribution of cells. Wassermann and Kahn reactions, urine and stool examinations, and agglutinations for *Br. abortus* were negative. An intracutaneous brucellergin test was negative; and the opsonocytophagic reaction revealed that the patient was susceptible. X-rays of the chest revealed a little calcium in the right root zone, but the lung fields and mediastinum appeared essentially normal.

The tentative diagnosis was Hodgkin's disease, and several right cervical nodes were excised for microscopic study. The report of the department of pathology was: "Capsule of lymph nodes thickened. Throughout there is complete obliteration of the usual lymphoid architecture. Follicles no longer visible. The lymphoid structures have been replaced by a disorderly array of cells of various types, including innumerable large giant cells, some multinucleated, of Dorothy Reed types. In addition one sees lymphoid cells, fibroblasts and endothelial cells, and a scattering of polymorphonuclears. There is a rather diffuse fine fibrosis throughout the nodes. Eosinophiles not present. All nodes show similar changes. *Diagnosis:* Hodgkin's disease, cervical lymph glands."

He was started on x-ray therapy, and received a total of 900 R. to each side of the neck over a period of two weeks with regression in the size of the glands. He also received two blood transfusions to combat a mild secondary anemia. During the first two weeks of his hospitalization the temperature ranged from 100

to 103° F., during the latter part the temperature rose daily to about 100° F. He was discharged Feb. 5, 1939, feeling much better with instructions to return to the tumor clinic for follow-up studies.

He returned to the hospital March 7, 1939, with the following complaints: daily rise in temperature to 102° F., night sweats, anorexia, weakness, and generalized aching body pains. A persistent and constant headache was accompanied at times by vertigo, tinnitus, and transient deafness. Edema of the ankles and swelling of the abdomen of two weeks duration had been observed.

Examination at this time revealed a slightly jaundiced condition, and the patient in the same malnourished state. The lymph glands of the neck were very small, just barely palpable, and felt fibrosed and matted together. The abdomen was moderately and symmetrically enlarged with shifting dullness and a fluid wave demonstrable. The liver and spleen could be palpated two fingerbreadths below the costal margin. There was moderate edema of the feet and ankles. Chest x-ray revealed no changes from those noted at the first examination.

Laboratory studies revealed some secondary anemia, the hemoglobin 68 per cent, red cell count 3,400,000, and white cell count 4,750. The icterus index was 16, total protein 4.4 per cent, with the albumin-globulin ratio 1.1:1. Blood cultures, agglutinations for *Br. abortus*, and the brucellergin skin test were negative. The opsonocytophagic reaction was again reported as susceptible. Blood urea was 22 mg. per 100 c.c.

It was assumed that the patient had involvement of the liver and retroperitoneal nodes with the Hodgkin's process. He was started on x-ray therapy and given a total of 1050 R. to the abdomen over a period of a week. He had a persistent, swinging temperature from subnormal to 102° F. and steadily declined in strength and weight in spite of high caloric diet, vitamins, iron, and seven blood transfusions. He steadily became weaker, lethargic, and more jaundiced with the highest icterus index 127, and died April 21, 1939.

Significant Autopsy Findings.—

Gross: The body was that of a fairly well-developed but markedly emaciated and dehydrated white man, deeply jaundiced. The right pupil was dilated and regular, the left being about the same size but irregular. Anterior and posterior cervical lymph nodes were moderately enlarged and firm. Previous biopsy incision had healed. The abdomen was rounded somewhat with a fluid wave evident. Axillary and inguinal nodes were decidedly enlarged and firm with a tendency to be conglomerate rather than discrete. Rather marked edema of the feet and ankles was present. On opening the abdomen, the viscera were in their normal relationship and the peritoneal cavity contained approximately 1,800 c.c. of amber colored fluid. Both pleural cavities contained between 150 and 200 c.c. of the same type of fluid. Numerous old, fibrous pleural adhesions were found on the left from apex to base, laterally and posteriorly. The other general findings were unimportant.

Lungs: Small, patchy areas of consolidation in addition to edema were present in the lungs.

Liver: Weight, 2,760 Gm.; 31 by 25 by 9 cm. The capsular surface was smooth and glistening with a rather mottled, brownish-yellow appearance. On section the cut surface was firm with small alternating areas of red and yellowish color corresponding in general to the lobular markings.

Spleen: Weight, 885 Gm.; 25 by 12 by 6.5 cm. The capsular surface was smooth and glistening. On section, the cut surface was deep reddish purple with widely distributed, irregular, yellowish areas of firm consistency.

Kidneys: Each kidney weighted 250 Gm. and measured 13.5 by 7.5 by 4 cm. The capsules stripped easily, leaving a pinkish-red surface studded here and there with small yellowish flecks. On section, cut surfaces showed an essentially normal archi-

tecture of cortex and medulla with the presence of many small, irregular, yellowish areas 1 to 2 mm. in diameter. These were present in both the cortex and pyramids. Both kidneys had similar changes.

Small intestine, colon, and appendix: Nothing significant was found except for a few small, punched out ulcerations in the terminal ileum.

Femoral Bone Marrow: Femoral bone marrow was pinkish red and hyperplastic in appearance.

Lymph nodes: Generalized enlargement of the axillary, inguinal, cervical, mediastinal, and all groups of retroperitoneal nodes was noted. Some nodes reached a diameter of 4 cm. On section they were yellowish white, very firm, and showed much scarring.

Permission for removal of the brain and neck structures was not granted.

Microscopic.—

Heart: The myocardium was normal except for scattered small nodules or foci consisting of groups of round cells and larger mononuclears lying in an intercellular, slightly acidophilic material. In at least two nodules were seen several yeastlike bodies although they were not definitely identified as torulae. The characteristic nodules occurred both in the ventricle and atrium.

Aorta: The aorta proper was normal. Just outside the adventitia was a small nodule of what seems to have been lymphoid tissue. It was replaced by scar, rather dense and containing small vascular spaces, both blood and lymph. There were granulomatous foci with mononuclears, a few polymorphonuclears, a few plasma cells, lymphocytes, and a few cells which resembled those of the Sternberg type. In many of the small lymphatic spaces there were the same mixed cells among which lay several yeast bodies.

Lungs: Areas of hemorrhage, edema, and early lobular pneumonia were found in the lungs; also several peribronchial nodules showing rather dense scarring with an admixture of remaining lymphocytes and many giant cells of the Sternberg type. Much pigment was present. In one or two foci, probably in lymphatics, there were small yeastlike bodies. They were difficult to identify.

Liver: In the liver widespread, nodular, granulomatous areas were present which appeared chiefly in the periportal regions, many having become confluent. Their cellular content consisted mainly of round cells, mononuclears, and giant cells as seen in the other organs. There were occasional eosinophiles but relatively few polymorphonuclears. No definite yeast bodies could be identified.

Spleen: There was widespread scarring and disturbance of architecture. Some of the same granulomatous areas were present as had been seen in the liver, but many areas showed a peculiar irregular zone of mononuclear cells filled with lipoid material. Yeast bodies were not definitely identified.

Kidneys: Scattered throughout the sections were more nodules, the distribution of which was irregular. Many involved glomeruli and surrounding tissue, but they occurred in both the cortex and medulla. The areas were essentially granulomatous, some with a tubercle-like appearance having definite necrotic centers; others had relatively clear central spaces. The peripheral zone of all contained round cells, mononuclears, and a few polymorphonuclears. Yeast bodies were numerous in these nodules, and some tubules were actually filled with them.

Adrenals: Structure was essentially normal, except for a number of small foci of cellular infiltration containing essentially the same cells as seen in the kidney nodules. Few polymorphonuclears were present. In one or two foci there were definite suggestive yeast bodies.

Lymph nodes, mediastinal: Widespread obliteration of normal architecture had occurred with replacement by a large amount of scarring and many large granu-

lomatous areas having the appearance of Hodgkin's disease. Giant cells of the Sternberg type were numerous. In addition there were numerous foci many of which had necrotic centers, others involving lymphatic channels, especially around the periphery of the nodes. These foci and lymphatics contained abundant yeast bodies both free and intracellular. In one node there was a large caseous tubercle containing calcium, apparently representing healed tuberculosis.

Abdominal, preaortic: The predominant feature was widespread scarring, much of which had hyalinized. Certain granulomatous areas persisted with remaining lymphocytes, Sternberg cells, occasional plasma cells but with a rare eosinophile. A few necrotic areas were present, especially in the hyalinized portions. In these many yeast bodies were present as well as definite "shadows" of yeast bodies. A few could also be seen in the remaining granulomatous areas. Some were present in lymphatics and also in one or two rather large veins around the periphery of the node.

Axillary: Normal architecture was practically replaced by a definite granulomatous process similar to that described elsewhere; scattered foci containing yeast bodies were present.

Inguinal: Intense old scarring was seen with replacement of all normal architecture. A few granulomatous areas remained, very similar to those seen in Hodgkin's disease. Yeast bodies were again identified in many areas, even a few in the veins around the nodes.

Peripancreatic nodes: A process similar to that seen in the other nodes with no normal lymphoid tissue was present. A good deal of hemorrhage had occurred. Many yeast bodies were in evidence.

Femoral bone marrow: A very definite hyperplasia with areas of mild gelatinous changes was found.

Vertebral marrow: Occasional foci of rather concentrically placed mononuclear cells were evident, which suggested the type of reaction caused by torulae, although none could be definitely identified. The remainder of the section showed rather crowded cellular marrow elements.

A guinea pig which had been inoculated with material from the abdominal cavity at the time of the autopsy died five weeks later, with the lungs, liver, spleen, and lymph nodes showing torula infection, the organisms identified in the tissues.

Comment.—This case adds another to the recorded instances of generalized torulosis. There have been thirteen in the literature reviewed. Although there is pathologic evidence of involvement of the lymph nodes and certain viscera, unfortunately, permission was not granted for removal of the brain. There were, however, definite signs and symptoms referable to the central nervous system, and it seems highly probable that the infection was present. This clinical evidence, however, did not occur until late in the course of the illness.

The fact that a pathologic diagnosis of Hodgkin's disease was made from a lymph node removed three months before death, adds further to the interest. A search of the literature reveals only a few cases where such a diagnosis was made prior to the known occurrence of the torula infection. This interval has varied from three months in the present case to five years in the cases of Freeman and Weidman, and Owen. The association of torulosis with Hodgkin's disease is rare and in most of the reported cases, the previous diagnosis of Hodgkin's disease was based on a somewhat atypical appearance of the lymph nodes in ques-

tion. In two such instances, torulae were later found in the original biopsy. In our case, we believe that the original diagnosis of Hodgkin's is justifiable microscopically, but certain atypical features were present. On reviewing the slides we have been unable to definitely identify torulae in the nodes, but the appearance of the latter was such as to raise the suspicion that they may have been present, i.e., that the nodes represented a healing process with torulae as the inciting agent. From the study of the autopsy material it seems evident that some of the lesions, especially in the liver and in certain lymph nodes, were compatible with Hodgkin's disease. On the other hand, torulae were found in all the lymph nodes studied and in many lesions which were similar to those seen in Hodgkin's disease. The lesions containing torulae varied somewhat in appearance depending on their age, some being necrotic foci without much reaction, others exhibiting a rather pronounced cellular response. All were essentially granulomatous.

From the evidence in this case and from others reported, one cannot escape the fact that torula infection produces granulomatous lesions which may closely simulate those seen in Hodgkin's disease. In the present study it seems certainly possible that the torula infection could have been the etiologic factor in producing the lesions encountered, lesions which were granulomatous and which might produce a picture both clinically and pathologically closely akin to Hodgkin's disease. We realize the difficulties in attempting to prove such a relationship and can only offer the evidence given here in discussing the question. This has been previously done, especially by Fitchett and Weidman.

As to the kidney lesions, they were apparently rather typical for that organ. Due to their location the organisms must have been excreted in the urine. This has been observed previously[8] and we again call attention to the possibility of identifying the yeast cells in the urine as a diagnostic aid.

CASE 3.—Mrs. C. I. (Hist. No. 146458), a white woman, aged 41 years, was admitted to the University of Virginia Hospital Feb. 13, 1939, with the complaint of pain and the occurrence of a mass in the right thigh.

The family, past, and marital histories were irrelevant.

She had first noticed a dull, aching pain on the inner aspect of the right thigh six months prior to admission. During the ensuing months the pain had been fairly constant, radiating down the medial side of the thigh into the calf fairly frequently, but never disabling. About six weeks prior to admission she had noticed the appearance of a nontender, firm mass about the size of an egg in the anteromedial aspect of the thigh. The mass had grown rapidly larger and extended around the thigh medially. No masses had been noticed anywhere else, nor any glandular enlargement. She had consulted her family physician, who had referred her to the hospital.

Physical examination revealed a firm, slightly tender, almost immovable mass of the soft tissues of the upper anterior and medial aspect of the right thigh, measuring 8 by 4 by 2 inches, with no skin or bony attachment. There was no redness nor increased heat, nor any enlarged glands in the groin. The remainder of the examination revealed no abnormalities. Her temperature was 99° F.

Laboratory study revealed no abnormalities except for some elevation of the leucocytes. Her hemoglobin was 84 per cent, the red blood cells 5,130,000, the white blood cells 11,200. Urine examination and Wassermann and Kahn reactions were negative. The blood calcium, phosphorus, and phosphatase were within the normal range.

As x-rays of the lungs and the hip and thigh regions were negative except for a hazy soft tissue shadow, the mass was aspirated and several plugs of tissue and much thick, glary, mucinous material withdrawn.

The initial report on the culture and smear from Dr. W. E. Bray's laboratory of clinical pathology was blastomyces, and from the department of pathology, blastomycosis of the soft tissues. Further cultures were taken and studied rather extensively by Dr. Bray and Dr. George M. Lawson of the department of bacteriology and public health with the conclusion reached by both that the organisms were not blastomyces but torulae. The diagnosis was based on the rapidity of the growth, the reproduction by budding, the failure to produce mycelia, and the morphologic and cultural appearance of the organism.

In spite of thymol administered systemically and by local injections, the mass continued to enlarge and extended posteriorly to the gluteal fold. The patient started running a low-grade fever, with temperature from 99 to 100° F. Amputation of the leg at the hip joint in an effort to eradicate the local lesion surgically was suggested Feb. 19, 1939, but due to the fact that there was no unanimity of opinion among the members of the surgical staff and that the patient's family had to be contacted, action was delayed until March 10, 1939.

On this date, under spinal anesthesia, disarticulation of the right leg at the hip joint was performed. During the procedure gelatinous exudate and diseased tissue were encountered, and the incision had to follow closely the pelvic bone in order to remove all diseased tissue. A drain was left in the wound, and the patient was given potassium iodide therapy systemically.

Cultures from the exudate encountered at the time of operation again revealed torulae. Pathologic examination of the thigh region revealed grossly a spacious irregular "abscess" cavity with the walls of the cavity ill-defined and dissecting between the muscle and fascial planes, at points seeming to destroy these tissues. The cavity had been cut into at its upper end and was filled with a viscid grayish-white, glistening, mucinous material, which was odorless. Microscopic examination of stained sections revealed almost complete loss of tissue in the central portions of the mass, with the tissue replaced by torulae, phagocytes, many of which contained torulae, polymorphonuclears and lymphocytes with mucinous intercellular material. Sections of the wall revealed a poorly developed type of granulation tissue reaction in which lymphocytes greatly predominated. The sections also showed foreign body giant cells and phagocytes containing debris and torulae. The surrounding muscles and soft tissues showed some round cell infiltration.

The patient was discharged on the twenty-second postoperative day, afebrile and with the stump almost healed. On a return visit six weeks later the stump had healed entirely, and there were no other manifestations of the disease.

She returned to the hospital Oct. 24, 1939 with the complaint of slight bloody drainage from a small area which had appeared in the center of the amputation scar ten days previously. Otherwise she had enjoyed good health. Examination revealed a sinus tract 2 mm. in diameter in the central portion of the scar which could be probed to a depth of 1 cm. There was no surrounding induration or tenderness. A smear from the sinus tract revealed bodies which appeared to be torulae. A culture, however, was negative for torula. X-rays of the hip and chest were negative. Under spinal anesthesia the tract was thoroughly cauterized and then completely excised. Examination of this tissue revealed a chronic inflammatory change in the tissues and a few bodies which may have been torulae, but these could not be definitely identified because of the effect of the cautery. She was discharged with the area healing satisfactorily.

She has been seen several times since discharge from the hospital. She has remained in good health and the stump healed with no sign of recurrence of the disease. June 25, 1943, she stated, in reply to a letter of inquiry, that she had had no further trouble.

Comment.—Case 3 represents the rare localized form of torulosis, like the soft tissue infections reported by Brewer and Wood, and McGehee and Michelson. The patient has apparently been cured following radical surgery. Internal administration of potassium iodide postoperatively was employed.

CASE 4.—Miss K. N. (Hist. No. 185353), a white woman, aged 24 years, was admitted to the University of Virginia Hospital, Dec. 3, 1942, with the complaint of headache, nausea, and vomiting.

The family and past histories were not significant.

She had developed a severe throbbing headache five days before admission to the hospital, which had not been relieved by the usual analgesics. Two days before admission nausea and vomiting had started.

Physical examination revealed the following abnormalities: blurring of the nasal side of both optic discs; slight stiffness of the neck on admission which in a period of twelve hours increased greatly; and a temperature of 101.4° F.

Laboratory studies were as follows: hemoglobin 68 per cent (Dare), red cell count 3,480,000, white cell count 11,000, with a smear showing a normal distribution of cells. Urine and stool specimens were essentially normal. The blood urea was 45 mg. per 100 c.c. A spinal puncture performed shortly after admission revealed a pressure of 200 mm. of water. The fluid was clear, there was a moderate increase in globulin, and a count of 80 cells, with a predominance of lymphocytes. A smear was negative, but the culture later showed torula.

Before the report of the positive culture, a diagnosis of benign lymphocytic choriomeningitis was made. Another spinal puncture revealed 390 cells with a predominance of polymorphonuclears. She was then given sulfadiazine for one day and sulfapyridine until four days before death. Potassium iodide was given by mouth, and acriflavine intrathecally. Torula organisms were recovered from the blood stream.

During the course of the illness she continued to complain of headache, steadily lost weight, and remained semicomatose or comatose most of the time. Repeated spinal punctures were done, and the spinal fluid pressure steadily rose to over 700 mm. of water. December 22, through bilateral postparietal burr openings, a ventriculogram was made in order to rule out internal hydrocephalus. The films revealed normal ventricles. On December 25, she lapsed into deep coma and respirations stopped rather abruptly. Permission for autopsy was not granted.

*Comment.**—This was primarily a case of central nervous system torulosis, the organism being recovered on smear and culture of the spinal fluid at many different times. There was one positive blood culture, although no other foci of infection were evident during the course of the illness.

CASE 5.—This is a follow-up report on Magruder's Case 3. To review briefly his protocol; she was a 22-year-old colored female, admitted to the University of Virginia Hospital on April 23, 1937, complaining of headache of three months duration, accompanied by pain in the neck of five weeks duration. She also had at various times, earache, tinnitus, photophobia, diminished visual acuity, anorexia, and vomiting. She was admitted in an irrational state and examination revealed

*This case will be reported in more detail by a member of the Department of Medicine.

definite choking of the optic discs, a large amount of exudate and several recent hemorrhages, slight stiffness of the neck, slight deviation of the tongue to the left, left biceps reflex greater than the right, sluggish patella reflexes, and absent Achilles tendon reflexes.

Laboratory work revealed no abnormalities except in the spinal fluid which showed yeastlike organisms which were cultured and identified as torula. She continued to have headache and transient spells of nausea and pain in the neck. Jan. 28, 1938, a culture of the spinal fluid revealed torula.

Since the last follow-up reported by Magruder, she returned to the outpatient clinic at various times complaining of backache, headache, nausea, and vomiting. April 29, 1940, these symptoms were accentuated, and examination revealed the right disc hazy and irregular in outline, with no other neurologic abnormalities noted. A lumbar puncture was performed with the initial pressure 160 mm. of water. The spinal fluid dynamics were normal, and the fluid was clear and colorless. The cell count was 142, with a predominance of lymphocytes. Colloidal gold curve was 5555553200. Spinal fluid protein was 225 mg., chlorides 710 mg., and sugar 21 mg. per 100 c.c. respectively. Torula organisms were again cultured from the spinal fluid. She died at home, May 6, 1940, having lived three years, four months after the onset of symptoms.

Comment.—Case 5 is one of torula infection of the central nervous system of three and one-third years, one of the longest cases on record. Wile reported a patient who may have had the disease seven years before death; Levin's patient died after five and one-half years, and patient in the case of Cudmore and Lisa[7] lived four years. Levin found the duration of the disease variable, with the majority of instances having one to six months of illness. In the present case torulae were repeatedly found on culture and smear of the spinal fluid. The patient received some alleviation of symptoms and returned to work temporarily following spinal drainage.

SUMMARY

A brief review of torula as it affects the human body has been given. Invasion of the central nervous system is most common, with an associated generalized form sometimes seen. Localized infections are rather infrequently encountered. The relationship of Hodgkin's disease and torulosis in the reported cases has been noted.

We have recorded four additional cases of torulosis. In the first, a case of central nervous system torulosis, the diagnosis was made at autopsy. In the second, a case of generalized torulosis, there were some central nervous system signs, in which a diagnosis of Hodgkin's disease was made previously from biopsy material. In the third, a case of localized torulosis of the thigh, an apparent cure was effected by radical surgery and the internal administration of potassium iodide. In the fourth, a case of central nervous system torulosis, the diagnosis was made by smear and culture of spinal fluid. A follow-up report of Magruder's third patient who died of cerebrospinal torulosis after three and one-third years was also given.

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REFERENCES

1. Alvarez, R. S.: A Red Torula as the Cause of a Tongue Abnormality, J. A. M. A. **87**: 1138, 1926.
2. Berghausen, O.: Torula Infection in Man, Ann. Int. Med. **1**: 235, 1927.
3. Binford, C. H.: Torulosis of the Central Nervous System, Am. J. Path. **11**: 242, 1941.
4. Brewer, G. E., and Wood, F. C.: Blastomycosis of the Spine, Ann. Surg. **48**: 889, 1908.
5. Cabot, R. C.: Torula Meningitis: Lymphoblastoma, Hodgkin's Type (Cabot Case 20241), New England J. Med. **210**: 1291, 1934.
6. Cudmore, J. H., and Lisa, J. R.: Torula Meningo-encephalitis: A Case Report, Ann. Int. Med. **11**: 1747, 1938.
7. Dandy, W. E., and Kindell, H.: Case Reported by Freeman.[10]
8. Fitchett, M. S., and Weidman, F. D.: Generalized Torulosis Associated With Hodgkin's Disease, Arch. Path. **18**: 225, 1934.
9. Freeman, W.: Torula Meningo-encephalitis: Comparative Pathology in Nineteen Cases, Tr. Am. Neurol. A. **56**: 203, 1930.
10. Idem: Torula Infection of the Central Nervous System, J. f. Psychol. u. Neurol. **43**: 236, 1931.
11. Freeman, W., and Weidman, F. D.: Cystic Blastomycosis of the Cerebral Gray Matter, Caused by Torula Histolytica Stoddard and Cutler, Arch. Neurol. & Psychiat. **9**: 589, 1923.
12. Frothingham, L.: A Tumor-Like Lesion in the Lung of a Horse Caused by a Blastomyces (Torula), J. Med. Research **9**: 31, 1902.
13. Gill, W. D.: Torula Mycosis in Man, With Special Reference to Involvement of Upper Respiratory Tract, Tr. Am. Laryng., Rhin. & Otol. Soc. **40**: 247, 1934.
14. Hardaway, R. M., and Crawford, P. M.: Pulmonary Torulosis, Report of a Case, Ann. Int. Med. **9**: 334, 1935.
15. Jones, E. L.: Torula Infection of the Nasopharynx, South. M. J. **20**: 120, 1927.
16. Levin, E. A.: Torula Infection of the Central Nervous System, Arch. Int. Med. **59**: 667, 1937.
17. Magruder, R. G.: A Report of Three Cases of Torula Infection of the Central Nervous System, J. Lab. & Clin. Med. **24**: 495, 1939.
18. McGehee, J. L., and Michelson, I. D.: Torula Infection in Man, Report of a Case, Surg., Gynec. & Obst. **42**: 803, 1926.
19. Mook, H. W., and Moore, M.: Cutaneous Torulosis, Arch. Dermat. & Syph. **33**: 951, 1936.
20. Owen, M.: Generalized Cryptococcosis Simulating Hodgkin's Disease, Texas State J. Med. **35**: 767, 1940.
21. Rappaport, B. Z., and Kaplan, B.: Generalized Torula Mycosis, Arch. Path. **1**: 720, 1926.
22. Reeves, D. L., Butt, E. M., and Hammack, R. W.: Torula Infection of the Lungs and Central Nervous System, Arch. Int. Med. **68**: 57, 1941.
23. Rusk, G. Y., and Farnell, F. J.: Systemic Oidiomycosis, Univ. California Publ., Path. **2**: 47, 1912.
24. Sheppe, W. M.: Torula Infection in Man, Am. J. M. Sc. **167**: 91, 1924.
25. Smith, F. B., and Crawford, J. S.: Fatal Granulomatosis of the Central Nervous System Due to a Yeast Torula, J. Path. & Bact. **33**: 291, 1930.
26. Stoddard, J. L., and Cutler, E. C.: Torula Infection in Man, Monograph 6, Rockefeller Inst. Med. Research, 1916.
27. Urback, E., and Zack, F.: Generalisiente Torulose, Arch. f. Dermat. u. Syph. **162**: 401, 1930.
28. Verse, M.: Ueber einen Fall von Generalisienter Blastomykose beim Menschen, Verhandl. d. deutsch. path. Gesellsch. **17**: 275, 1914.
29. Von Hansemann: Ueber eine bisher nicht Beobachtele Gehirnerkrankung durch Hefen, Verhandl. d. deutsch. path. Gesellsch. **9**: 21, 1905.
30. Warvi, W. N., and Rawson, R. W.: Torula Meningitis, Arch. Int. Med. **69**: 90, 1942.
31. Watts, J. W.: Torula Infection. A Review and Report of Two Cases, Am. J. Path. **8**: 167, 1932.
32. Weidman, F. D.: Cutaneous Torulosis, South. M. J. **26**: 851, 1933.
33. Weidman, F. D., and Ratcliffe, H. L.: Extensive Generalized Torulosis in a Cheetah, Arch. Path. **18**: 362, 1934.
34. Wile, U. J.: Cutaneous Torulosis, Arch. Dermat. & Syph. **31**: 58, 1935.
35. Zenker: Encephalitis mit Pilzenwickelung im Gehirn, 1861, Jahresv. d. Gesellsch. f. Natur. u. Heilk in Dresden, page 51. (Quoted by Freeman.[10])

A "LUCITE" GASTROSTOMY TUBE FOR POUCH DOGS AND POSSIBILITIES FOR APPLICATIONS IN MAN

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NO SINGLE procedure has contributed as much to our knowledge of the physiology of gastric secretion, as has the study of gastric juice obtained from the isolated gastric pouch in dogs. Since the isolation of gastric pouches by Heidenhain and Pavlov, many types of cannulas have been devised of various materials for the collection of the pouch juice. Few have been completely satisfactory. Most failures have been due to (1) the use of a material giving rise to tissue irritation, (2) removal of the cannula by the experimental animal, and (3) seepage about the gastrostomy tube. Dragstedt and associates[2, 3] has employed a gold plated cannula with satisfaction.

In this laboratory different types of metals and alloys have been used with little success.[7] During the past few years, a No. 30 French rubber mushroom catheter, anchored from the inside, to the lowermost costal cartilage has given the best results. When this method was used, a number of dogs pulled out the tubes. A high mortality resulted from attempted reinsertion of the tube, and in some dogs a second operation was necessary. Thomas[9] reported in his experience, over a period of eight years, that approximately one-half of their animals were lost within the first few weeks after operation because of cannulas coming out, being pulled out, or destroyed by the animal. Our own experience suggested a search for a more satisfactory substitute.

"Lucite" was used in medicine by McCrea,[8] in 1938, when he reported two cases in which "lucite testicles" were implanted into the scrotal sac. Examination one year later revealed no outward evidence of tissue irritation. Dennis[1] employs lucite drains in the surgical treatment of pyogenic osteomyelitis. He observed that subcutaneous implantation of lucite in animals revealed a moderate tissue reaction. In 1943, Harmon[6] fashioned plastic cups of lucite and "plexiglass" for arthroplasty of the hip in cases of osteoarthritis with satisfactory results.

Lucite,[4] a plastic resin, is a polymeric alpha-methyl-methacrylate—a compound ester of acrylic type. It is unaffected by aqueous solutions of mineral salts of dilute alkalies. Lucite is resistant to hydrochloric acid and 50 per cent sulfuric acid at room temperature. It is insoluble in straight chain hydrocarbons, fats, oils, and waxes. Lucite is readily

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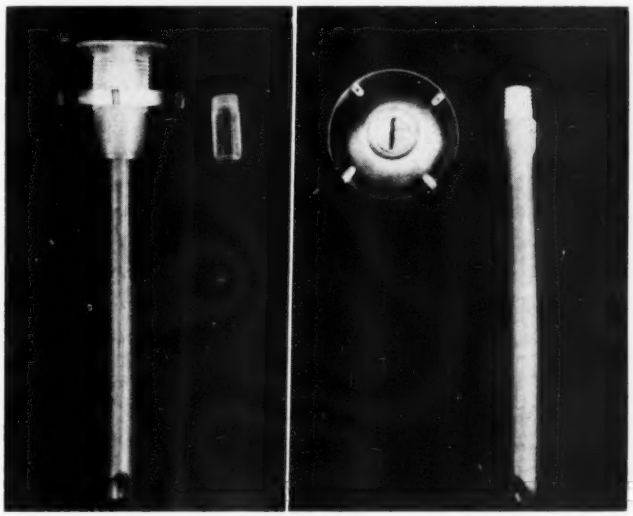
dissolved by lower ketone and ester solvents and mixtures of aromatic hydrocarbons with small amounts of alcohol.

The physical properties of lucite are:

1. Specific gravity is 1.18 to 1.20.
2. The water absorption of lucite is negligible.
3. Tensile strength, 9,000 to 12,000 lb. per square inch (approximately the same tensile strength of cast zinc; two to three times that of cast or drawn tin; three to four times that of cast or drawn lead[5]).
4. Transverse (flexural) strength 12,000 to 14,000 lb. per square inch.
5. The impact resistance and hardness are sufficient to withstand body strains.

Cast lucite in the form of sheets, rods, and tubes will soften at temperatures from 190 to 240° F. It is colorless and has a high light transmission. It can be cut, molded, easily machined, drilled, and polished. Pieces can be cemented together by active solvents or lucite cement. Such joints are mechanically as strong as the material itself.



A. *B.*

Fig. 1.—*A*, Photograph of the "lucite" gastrostomy tube, with the tubular middle piece inserted and the rubber tubing attached. *B*, End-on photograph of the lucite gastrostomy tube with the solid middle piece inserted.

In September of 1942, we first used a lucite gastrostomy tube in a pouch dog. Modifications of the original design were made until a satisfactory mechanism was found. (See Figs. 1 and 2.)

Operative Procedure.—The dog is prepared for surgery in the routine manner. Intratracheal ether or intravenous sodium pentobarbital (15 mg. per pound of body weight) is used. A left mid-rectus incision is made, and the stomach is identified. A gastric pouch is fashioned from the greater curvature of the stomach. Approximately three quarters of the mucosa of the isolated gastric pouch is then inverted by a running Connell suture (catgut No. 000). Following this, conduit *A* (see Fig. 2)

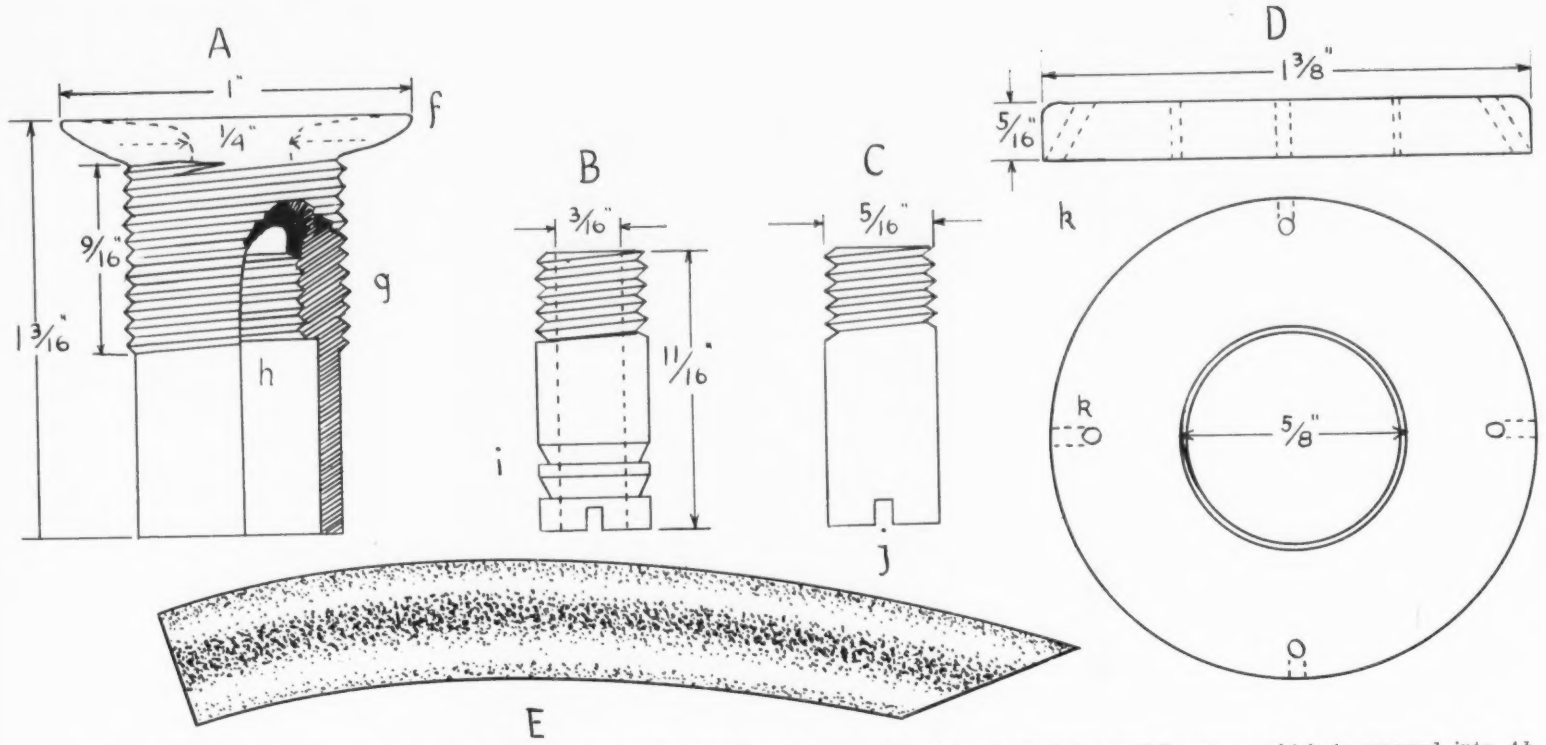


Fig. 2.—*A*, Single piece conduit (*f*, inner shoulder; *g*, outer threads; *h*, inner threads). *B*, Tubular middle piece, which is screwed into *Ah*, after rubber tubing, *E*, has been slipped over corrugated surface, *Bi*. *C*,* solid middle piece which is interchangeable with *B*. Both middle pieces have screw slots, *j*. *D*, Outer shoulder which is screwed upon *Ag*. *k*, Angulated holes perforating *D*.

*Solid middle piece, *C*, is of little value for use in pouch dogs except for the intermittent collection of pouch juice. For use in man this part has other implications, which will be discussed briefly.

is inserted into the pouch. A stab wound is made through an area of the pouch wall away from the line of closure of the pouch. This procedure permits conduit *A* to be pulled through so that the inner shoulder *f* rests against the gastric mucosa. The Connell suture of the mucosa is now completed. A Murphy inverting stitch or purse-string suture is taken in the pouch wall about the conduit and tied. Rubber tubing, *E*, is inserted over *Bi*, and *B* is screwed into *Ah* (see Fig. 2). The serosa-to-serosa closure of the pouch is now completed with Halsted interrupted mattress sutures of cotton. The residual stomach is closed in a similar fashion. A puncture hole is then made through the omentum, and the gastrostomy tube is pulled through. This maneuver allows omentum to surround the isolated pouch. The abdominal wall, including the anterior rectus sheath, is now closed about the gastrostomy tube. Shoulder *D* is then screwed onto *Ag* until the serosal surface of the pouch is pulled snugly against the anterior abdominal wall (see Fig. 3). Shoulder, *D*,

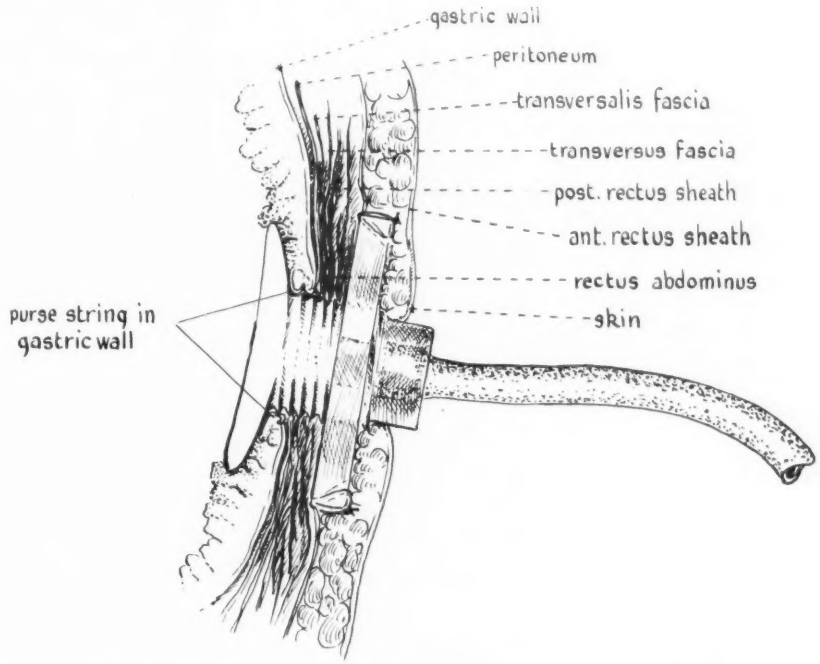


Fig. 3.—A sagittal section of the abdominal wall with the lucite gastrostomy tube in situ. (Gray's Human Anatomy.)

is sutured to the anterior rectus sheath through the angulated holes, *k*. The subcutaneous tissue and skin are closed over shoulder, *D*. Sulfanilamide is used intraperitoneally and in the abdominal wall. An ordinary spool of cotton thread, No. 40, is used exclusively in the abdominal wall closure. At the conclusion of the procedure approximately one-eighth inch of conduit *A* extends above the skin. Postoperative edema causes conduit *A* to become immediately subcutaneous after two or three days.

The sterilization of the unassembled gastrostomy tube is accomplished by immersion in 1:2500 dilution of metaphen for one hour. No gross infection was noted in any case. McCrea[8] used formaldehyde for sterilization. A 5 per cent concentration of formaldehyde U.S.P. (neutral) has no effect on lucite. Harmon[6] used mercuric oxycyanide (0.2 per cent solution) and mercuric chloride (0.1 per cent solution) for sterilization.

We have performed eight such operations. The final gastrostomy tube was used in the last three dogs. These three dogs died, soon after operation, of distemper which was epidemic in the laboratory at the time. No death occurred incident to the use of the lucite gastrostomy tube. The gastrostomies were functioning well before death.

Dogs examined at autopsy or operation revealed the tissue to have hugged the lucite gastrostomy tube intimately. This tissue immediately surrounding the tube grossly appeared to be fibrous in character. The gastrostomy was watertight. The inner shoulder, *f*, of conduit *A* was slightly blackened. This was cleaned with ease. The threads were intact and not distorted.

This lucite gastrostomy tube has the following advantages:

1. It cannot be removed by the dog.

2. If the rubber tubing is pulled off it can be replaced easily without risk to the animal. This can be done by unscrewing the middle piece, *B*, and using the screw slot, *j*, while holding the end of conduit *A* with a hemostat. This precaution should be taken because theoretically conduit *A* would tend to unscrew off shoulder *D*.

3. It is watertight.

4. It has the advantages of lucite.

POSSIBILITIES FOR APPLICATIONS IN MAN

This gastrostomy tube could be used in patients in whom a permanent gastrostomy is contemplated. The middle piece, *B*, with rubber tubing attached would be used for feeding while solid plug, *C*, would be used between feedings to prevent any leakage of gastric contents onto the skin.

For use in man, the following modifications are recommended: (1) Increased diameter of the aperture of conduit *A;* (2) increased overall length of this conduit with attendant changes in the placement of the threads, length of middle piece *B*, etc.; (3) a wider inner shoulder *f;* (4) end of conduit *A* squared so that it may be easily grasped; (5) winged middle pieces *B* and *C* so that they may be interchanged without the aid of a mechanical device.

We have also used this lucite tube for cystostomy in a dog to determine its applicability for permanent cystostomy in man. The cystostomy tube in this animal was closed at all times by the insertion of a solid middle piece, *C*, at the time of operation. After 141 days this dog was

sacrificed. A stone 1 by ¾ inch was found in the bladder. This calculus was completely detached from the lucite tube.*

Subsequently, a lucite screw was implanted into the urinary bladder of another dog. One hundred forty-one days later, the screw was recovered from the bladder. It was clean, the threads were intact, and no encrustations nor calculi were present. Perhaps the insertion of the cystostomy tube in the first animal distorted the bladder sufficiently to allow urinary stasis with resultant stone formation.

Recently, we repaired an artificially made abdominal wall defect in a dog with a lucite plate. Although the lucite plate fitted well, satisfactory fixation to the tissues was technically difficult. A few days later it was necessary to reoperate upon this dog and attempt fixation again. Infection occurred and the plate was removed. If a satisfactory method of fixation can be devised, the use of a lucite plate for the repair of hernial defects may prove feasible.

CONCLUSIONS

1. A lucite gastrostomy tube for pouch dogs has been described with a note concerning its possible applications in man.

2. Lucite has physical, chemical, and workable properties satisfactory for use in tissues.

3. We have been encouraged with the behavior of lucite and feel that in tissue defects which cannot be reconstructed satisfactorily by surgery, nonreactive plastic materials should be investigated to ascertain their value.

REFERENCES

1. Dennis, C.: Prolonged Dependent Drainage With "Lucite" Drains in the Treatment of Chronic Osteomyelitis, SURGERY **13**: 900, 1943.
2. Dragstedt, L. R., and Ellis, J. C.: The Fatal Effect of Total Loss of Gastric Juice, Am. J. Physiol. **93**: 407, 1930.
3. Dragstedt, L. R., Montgomery, M. L., and Ellis, J. C.: A New Type of Pancreatic Fistula, Proc. Soc. Exper. Biol. & Med. **28**: 109, 1930.
4. Dupont De Nemours and Company: Manual on "Lucite."
5. Handbook of Chemistry and Physics, 25th edition, 1941-1942, published by Cleveland Rubber Company.
6. Harmon, P. H.: Arthroplasty of the Hip for Osteoarthritis Utilizing Foreign Body Cups of Plastic, Surg., Gynec. & Obst. **76**: 343, 1943.
7. Hay, L.: Unpublished data.
8. McCrea, L. F.: Lucite: A New Synthetic Material Suitable for Testicular Prosthesis, Urol. & Cutan. Rev. **42**: 723, 1938.
9. Thomas, J. E.: An Improved Cannula for Gastric and Intestinal Fistulas, Proc. Soc. Exper. Biol. & Med. **46**: 260, 1941.

*Also, in this instance, nonabsorbable cotton sutures were used in the closure of the bladder. It is possible that one of the sutures sloughed into the bladder and formed a nucleus for the calculus found.

Editorial

Use of Nonabsorbable Sulfasuxidine in Extensive Burns

THE search for an adequate treatment of the extensive burn case has rivaled that of Diogenes and only during the last two decades has it been done in the manner of other medical researches. There is no doubt that Davidson, in 1925, when he suggested the use of tannic acid, gave a really noteworthy stimulus to this investigation.

The better understanding of shock in burn cases and the use of blood plasma have presented the surgeon with the problem of completing successfully the treatment of the extensive third degree burn case. Many of these patients have a minimum of skin for donor sites for skin grafting and require multiple grafting procedures over a considerable length of time. We are then confronted with the rather difficult problem of keeping the burned area clean enough for skin transplantation without resorting, unless absolutely necessary, to the temporary use of homografts.

The use of any type of closed treatment with eschar formation must necessarily be at least a temporary postponement of the eventually necessary replacement of the destroyed skin. A better plan is a semiclosed method which can be opened at the earliest time that grafting can be done or when any complications arise. With this in mind, many treatments have been devised since the advent of sulfonamide therapy, all using sulfanilamide, sulfathiazole, or sulfadiazine as the bacteriostatic agent. Their value has been described by many authors. However, the dangers of using these drugs in the large quantities necessary in extensive burns are well known. The kidneys must excrete up to 29 per cent of the dose of the sulfonamides, according to Matthews, which places a rather severe strain on the renal function, especially one that is already probably taxed to the limit by the burn itself.

With these considerations in mind, during the past year, the nonabsorbable sulfonamide, sulfasuxidine, has been used in a series of extensive burns as the bacteriostatic agent and has been found to facilitate earlier multiple grafting operations. The cases have had total third degree burns of from 20 to 45 per cent of the body surface according to Berkow's tables. Up to 25 Gm. of sulfasuxidine have been dusted on the granulating areas and then a pressure dressing of boric acid ointment applied.

Under this regime the patients have never shown any toxic effects and repeated blood concentrations have always been zero. Those who were having rather high temperatures have had noteworthy reduction in fever. The method has been decidedly easier on the patients than some treatments as the dressings are not changed for periods of from four to eight days. The granulation tissue has become and remained clean enough for multiple transplantation of large split grafts, without the loss of any grafts.

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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

WOUND DISRUPTION AND CATGUT ALLERGY—AN EXPERIMENTAL AND CLINICAL STUDY

WITH A REVIEW OF THE LITERATURE

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THE problem of wound disruption in abdominal surgery is entirely one of wound healing and has been the subject of lengthy investigagation. The first report in the American literature was that of Brehauer,[1] who in 1899 reported 3 cases of disruption. The first comprehensive report was published by Madelung,[2] in 1905, when he reviewed 157 cases including 13 which he and his associates had observed. Ries[3] gave an account of 6 cases, in 1909. In 1925, Holterman[4] reviewed 15 cases which represented an incidence of 2 per cent in a series of operations performed. In the same year, Shipley[5] described a method of secondary closure of disrupted wounds by the use of silver wire which could be tightened up over buttons. In 1931, Sokolov[6] published data on 725 cases of wound disruption he had compiled by sending out questionnaires to many European surgeons.

The symposium on wound disruptions conducted by the New York Surgical Society, in 1933, was the most important event in drawing to the attention of the American surgical profession the prevalence of this postoperative calamity, for many surgeons had accepted dehiscence as an unavoidable disaster or act of God, which of necessity must occur in a small percentage of cases.

Before we assume that the healing powers and the stimuli to heal are defective or absent, we must make certain that delayed healing is not due to impediments which we have put in the way. Nature works methodically: the removal of debris, blood clots, dead tissue, and bacteria must precede actual repair. To a large degree, both the systemic and the local factors which may affect repair are under the surgeon's control.

FACTORS INFLUENCING WOUND HEALING

The gross and microscopic changes coincident with wound repair are well known as are also many of the factors which influence them. The

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actual reparative stimuli, which appear to be protein in nature, are derived from leucocytes and other tissue-wandering cells and connective tissue.[7] These have been the subject of many studies. As to the actual nature of the healing process, however, how and why these growth-promoting substances act, we know very little, except to say that healing appears to be a natural property of living organisms, which under certain optimal conditions proceeds at a definite and measurable pace.

The factors which have to do with normal healing may be divided into those which act directly at the site of the injury, the local factors, and those which have an effect of a more general nature and act systemically.

GENERAL FACTORS

Malignant Disease.—The effect of malignant disease in retarding wound healing is a common observation. Malignancy is undoubtedly an important factor in the etiology of disruption as evidenced by its frequency of 25 per cent in the large group of cases studied by Jenkins.[8] To what extent anemia, old age, and poor nutritional state contribute to this observation is difficult to evaluate accurately. In the absence of malignancy the latter factors are also observed to influence the rate of healing of a wound.

Hypoproteinemia.—The effect of protein on wound healing deserves special reference since it has been exhaustively studied and very definite clinical evidence supports critical experimental work. The effect of protein on wound healing was suggested by experiments of Clark[9] and Harvey and co-workers,[11] and recently by Thompson, Ravdin and co-workers.[10] Carrel showed that the stimulus for wound healing was a protein, probably an embryonic type of protein, not present in all tissues but apparently occurring in white blood cells, tissue wandering cells, and connective tissue. Clark[9] found delay in healing in animals fed on low protein diets. Harvey and Howes[11] showed with experiments on guinea pigs that with high protein diets wound healing progressed about the same as with low protein diets. The latent period was the same; however, once fibroblastic proliferation started it proceeded more rapidly in animals on a high protein diet. Thompson, Ravdin, and co-workers have demonstrated, both with experiments and clinical observations on blood proteins in wound healing, that when hypoproteinemia exists, wound healing is retarded or may even cease and that when the protein is brought up to normal by the use of lyophile serum, normal healing takes place.

Howes, Sooy, and Harvey[12] have demonstrated experimentally that there is a quiescent phase, or "lag period," in the healing of a wound, during which time its tensile strength per se is zero. This period usually extends from four to six days. Clark[9] found that this period was susceptible to dietary control and could be reduced by a high protein

diet. But Harvey and Howes[11] contradict that statement and maintain that a high protein diet, while responsible for an acceleration in the rate at which the wound heals, does not alter the duration of the initial lag period. The first five or six days of wound repair are the critical days. During this time, the lag period or exudative phase of wound repair, the stage is being set for the abrupt onset of fibroplasia. Necrotic tissue is being liquefied and removed, bacterial contaminants are being dealt with, and an increasing local resistance to bacterial invaders is developing. The tensile strength of the wound during this period depends almost entirely upon the sutures and the relaxation obtained by rest and splinting. Rest and avoidance of unnecessary manipulation are therefore particularly essential to proper healing during the exudative phase. It is at this time, as DuMourtier[13] has shown, that the sutured wound is more susceptible to infection. Following the lag period the tensile strength of the wound rapidly increases until the maximum level is reached in from ten to fourteen days. Probably the most significant aspect in the healing of any wound, as far as the clinical application of the physiologic mechanism is concerned, is the presence of a lag period with its concomitant negligible tensile strength. It is obvious that during this period the wound requires support to maintain coaptation of its margins.

Koster and Kasman,[20] in a study of serum proteins in a series of 40 wound disruptions and 40 well-healed controls, concluded that "hypoproteinemia by itself is neither a necessary nor a sufficient cause for wound disruption, but a poor nutritional state of which hypoproteinemia is a manifestation may favor wound disruption."

Vitamin C.—Vitamin C is intimately related to the production of fibrous tissue, and hence becomes an exceedingly important factor in the repair of wounds. Vitamin C deficiency as a cause for disturbances of wound healing was suggested by Sokolov[6] in a study of postoperative wound disruption, when he found that wound disruption occurred with greater frequency during the late winter and early spring months and expressed the idea that this was due to vitamin deficiency since the patients from whom the statistics were drawn were of the northern European races whose vitamin C intake was much curtailed during winter. Subsequent experimental studies and clinical investigations by Lanman and Ingalls[14] have definitely borne out Sokolov's original suggestion, for they found that in guinea pigs placed on diets low in vitamin C incisions healed poorly, more slowly, and with the development of less tensile strength than in the normal controls. In addition, they observed the case of an infant with congenital atresia of the intestine in whom wound disruption occurred following operation. Tissue studies after death showed typical changes of scurvy. Taffel and Harvey[15] conducted similar experiments and found that in scorbutic guinea pigs there was definite delay in the development of normal tensile strength in healing wounds.

It has been pointed out that normal repair of wounds takes place through a process of fibroblastic proliferation of connective tissue and the formation of collagen. While it is true that severe malnutrition is in itself a deterrent to normal wound healing, it seems that vitamin C is a particularly important factor in this connection. Metheny[16] gives several case reports of patients in whom delayed wound healing was brought about by deficiency of vitamin C, and he therefore advocates that undernourished patients be tested for vitamin C content of the blood, and where this is less than 1 mg. per cent, the patient be given a sufficient amount of ascorbic acid to bring the blood vitamin C to this level. Lauber and Rosenfeld[17] also have advanced evidence to prove that vitamin C deficiency results in serious interference with tissue regeneration and wound healing. The presence of disease, especially of the gastrointestinal tract, often causes radical changes in the dietary habits and almost invariably results in improper nutrition. Thus, the patient who has suffered from peptic ulcer, malignancy of the gastrointestinal tract, or other types of cachexias and food deficiencies is the one most frequently subject to wound disruption. Such patients may often show low vitamin C content in the blood even though there are no actual signs or symptoms of scurvy.

Other General Factors.—There are a certain number of general factors which have a direct or indirect effect upon wound healing. Carrel[7] has shown that the healing of wounds occurs at a rate inversely proportional to age, and other investigators have confirmed this observation. We are all familiar with the delayed healing which may occur in the aged, but we all know also that healing does occur in the aged as well as in the young, and that often the disease rather than age alone is the more important factor. Mason[18] has stated that even in acute starvation healing proceeds as usual unless the starvation actually threatens life itself. The urge to heal is almost equal to the urge to live, and nature will surmount all obstacles to close a wound. Certain diseases such as diabetes and nephritis retard healing, through what mechanism we cannot be certain, although we must think of hypoproteinemia and anoxemia. Dehydration of even moderate degree has a marked depressant effect upon repair in general and experimentally. Anderson[19] has shown it to lead to striking weakness in healing wounds. Distant infection is said to have a deleterious effect upon wound healing and this statement is supported by Carrel's experimental work.[7]

LOCAL FACTORS

Débridement.—It is a universally accepted surgical principle that foreign matter including nonviable tissue must be removed from a wound if normal healing is to be expected, because removal of such material must precede the fibroplastic reaction essential to tissue union. Removal by leucocytes is a laborious and slow process, so the less such material is left in the wound by the surgeon, the less will be the delay

in healing. The second reason for débridement is even more important. Foreign material acts as a nidus for infection, as will be emphasized in the subsequent discussion of nonabsorbable suture material, and permits bacteria to adjust to their environment and begin to grow before white cells gain access to them. Pickrell[68] has shown that if bacteria are introduced into the body during deep surgical anesthesia, they will grow uninhibited by the defenses of the body during the entire period of unconsciousness, and this, regardless of the amount of immunity possessed by the body against the bacteria. If bacteria are able to grow unrestrictedly during several hours, they may easily become so numerous that inflammation developing after recovery of consciousness may be unable to overcome them.

Method of Placing Sutures.—A corollary of the débridement procedure is that suturing must create as little nonviable tissue in the wound as possible. This necessitates using a minimum of sutures, which is accomplished by well-advised placing of sutures, and taking small bites so that the inevitable mass of strangulated tissue may be minimized.

Electrosurgery.—The experimental and clinical work of Ellis,[34] Magyary,[35] Hauberrisser,[36] and others has shown that wounds produced by electrosurgical units do not heal as well or as quickly or gain tensile strength as rapidly as similar wounds produced by a knife. The necrobiotic zone produced by the current must be dealt with before healing can take place, and, by analogy, to a lesser degree, the same holds true in wounds where hemostasis has been accomplished by the coagulating current. The disturbance is most marked in the skin, less so in fat and muscle, while in brain the burn seems to heal almost as well as a sharp wound.

Infection.—We may begin with the assumption that every wound, regardless of how it is made—operatively or accidentally—is contaminated. Meleny[21] has shown that even in a well-appointed operating room bacteria fall on a petri dish at a rate of 1 to 2 per minute and similar studies made elsewhere have confirmed these findings. Ives and Hirschfield[22] have made cultures from clean operating rooms at various intervals from the time of skin incision to the time of closure and have found that positive cultures can be obtained from the subcutaneous tissues in practically 100 per cent. Even the peritoneum can be shown to be contaminated in almost 90 per cent. These wounds all healed by primary intention. When organisms gain entrance to tissues they do not at once begin to grow, but lie dormant for some time until they become acclimated to their new environment, and after this period of incubation has passed, growth occurs, and the wound is infected.

However, within the past few years, largely because of researches made by Meleny, Hart, Truesdale, and others, efforts are being made to sterilize or at least materially reduce the bacteria content of operating room air, with reduction of postoperative infection.

The presence of infection has been clearly shown to hasten the disintegration of catgut. Howes and Harvey[23] found that the chromic catgut of one manufacturer showed complete loss of tensile strength within six days, regardless of whether it was 20- or 40-day variety. The rapid digestion of 20-day catgut in apparently clean disrupted wounds, which has frequently been observed by many surgeons, may be attributed in numerous instances to the presence of some degree of infection which was not associated with perceptible suppuration. Suppurative or nonsuppurative infection may be localized to a small focus in a wound. If it occurs anywhere along the course of a continuous suture, the continuity of the catgut is lost at that point from rapid digestion. A disruptive force could then easily cause the remainder of the continuous suture to pull loose with subsequent separation.

Infection of a wound also may cause lysis of the fascia in which the sutures are placed, due to bacterial enzymes. This causes sutures to pull loose and affects silk-closed wounds as well as gut-closed ones.

Drainage.—In the American series of disruptions one-third of the patients in the reported cases were drained. When the European cases, except those of Madelung, are also considered, it is found that one-sixth of the total were drained. Colp[24] found that the incidence of disruption was 1.22 per cent in a series of 1,147 cases with drainage as compared with 0.84 per cent in 1,603 laparotomies in which there was no drainage. The use of a drain usually implies the presence of suppuration, except in instances in which the drainage is a precautionary measure as in cholecystectomy. It is a question whether the presence of intraperitoneal infection is not of more significance as an etiologic factor than the drain itself.

The technique of closure in the presence of a drain may influence the incidence of disruption to some extent. The use of a continuous suture would seem to be especially undesirable. The presence of intraperitoneal suppuration would certainly lead to infection of the tissue in proximity to the drain. The continuous suture which is tied adjacent to the drain would undergo rapid digestion in the presence of the infection at this point, and the continuity of the suture would be lost long before adequate healing had occurred in the rest of the wound. It would appear to be safer to use a separate stab incision for drainage whenever this is feasible. If the separate point of drainage is not feasible, one should at least put in several interrupted sutures adjacent to a drain before beginning a continuous suture of the remainder of the wound.

Strain on the Healing Wound.—The presence of postoperative complications which result in great intra-abdominal pressure has been emphasized as an important factor by Glasser,[25] Milbert,[26] and others. The constant pressure from distension and the sudden force of coughing, vomiting, retching, and hiccoughing undoubtedly play an important role in disruption. Crying in infants puts a tremendous strain on

the wound. When delirious or unruly patients get out of bed shortly after operation, they are likely to put an undue strain on the incision. Attempts to restrain such patients may result in an equally severe strain on their wounds if they thresh about. In coming out of anesthesia some patients are difficult to control. Two instances of audible breaking of the sutures under such circumstances have been reported by Ries,[3] and others have felt that the separation of the fascia in some cases undoubtedly dated back to this particular time.

The use of an abdominal binder has not been universally accepted as a method of relieving the tension which may be exerted on a wound during convalescence. The disadvantage of limitation of respiratory movement has been claimed by some to overcome any advantage that it might have in preventing strain on the wound. Most surgeons, however, feel that the use of a binder is a justifiable precaution either as a routine or in selected cases. Additional support may be obtained by using adhesive tape over the dressings.

Anatomic Aspects of the Abdominal Wall.—The upper abdomen is most frequently approached through a rectus incision. Because of the preponderance of transverse fibers in the posterior sheath of the rectus, it is frequently found that the sutures of any type may easily pull through this layer, as pointed out by White.[27] This is especially true when the patient has a thin posterior sheath or when the patient takes a poor inhalation anesthesia. When there is inadequate anesthesia this layer may be torn to shreds before the closure is completed. The importance of a "difficult sew-up" is stressed by Grace.[28] Koster and Kasman[29] believe that the low incidence observed in their series was due, to some extent, to the use of spinal anesthesia which permitted a more complete degree of relaxation during the closure of the wound.

When the sutures are placed close together in the anterior sheath at the same distance from the edge of the incision, it has been observed by White[27] and Ries[3] that the fascia may become so weakened by the multiple perforations that it will tear longitudinally, similar to the way postage stamps may be torn apart.

On the basis of anatomic considerations the McBurney incision appears to offer the safest approach to the abdomen even though disruptions following this incision have been mentioned by Maes, Boyce, and McFetridge[30] and Sokolov.[6]

Tension Sutures.—The use of tension sutures as a supplement to a catgut suture has been frequently recommended, especially in instances when the surgeon might anticipate delay in wound healing or early digestion of catgut from infection. There are some features about the use of tension sutures in wounds closed with continuous catgut which deserve analysis from a purely mechanical point of view. If a tension suture is tied too loosely, it will not give any support to the wound unless the overlying fascia separates. Then its support is mainly that of the skin and subcutaneous tissue. It would help prevent eviscera-

tion but would not impede separation of the fascia. If the tension suture is tied too tightly, it is usually observed to cut through the skin. It, no doubt, cuts through the anterior sheath to some extent at the same time. It is not difficult to visualize the tightly tied tension suture also cutting through a continuous suture in the anterior sheath. If the tension suture is tied in such a way that it gives some support to the wound without falling into the category of being too tight, even then it may be harmful to a continuous suture in the anterior rectus sheath. The mechanics involved in this situation, as pointed out by Meleny and Howes,[31] appear to be similar to a lateral pull on either side of a wire loop. Under such circumstances, the circle changes to an oval in shape with decrease in the vertical diameter, which depends on the amount of force exerted. The effect of lateral force on a wound would tend to flatten out a circular tension suture. Thus there would develop downward force against the skin and upward force against the anterior sheath. Depending on the strain exerted on a wound, the tension suture would then be expected to cut through the skin and fascia to some extent. In cutting through the fascia, it would also disrupt the continuity of the suture in the anterior sheath. The use of U-shaped tension sutures instead of the circular type would not necessarily prevent it from cutting through the fascia when tied too tightly or when any strain is put upon the wound. Judging from these purely mechanical aspects, it does not seem appropriate to use a continuous suture in the presence of tension sutures. If one does use tension sutures with continuous catgut, it would seem preferable to put them in sufficiently close together so that they would constitute adequate approximation of the wound, irrespective of the catgut.

Surgical Knots.—It has been shown that the weakest part of any suture or ligature which is subject to tension is the knot which secures the suture ends.[8, 32] It is usually assumed that the knot that the surgeon ties is faultless. If this is so, then the next weakest link is that portion of the suture material immediately adjacent to the knot. At this point the suture has been sharply kinked and some of the fibers fractured by sharp turns imposed by the knot. Taylor[33] found that a carefully made square knot or surgeon's knot was reliable when tied with ordinary silk or linen, but when boilable plain or chromic catgut was used, although it held fairly well, it was by no means absolutely safe. He adds that these same catgut knots become completely untrustworthy if immersed in either saline solution or serum before testing, so that they swell and become capable of stretching; yet a boilable catgut which has not been made adequately pliable by moistening is very difficult to tie securely. He found that the same was true of the nonboilable type of catgut. When plain catgut was used, Taylor[33] had never been able to tie a square knot which would hold if tied wet and in the manner used in making ties under operative conditions. He also stressed the importance of not cutting the ends

too short, for even slight tension may cause the ends to slip allowing the entire knot to become untied. These points are of particular significance when a continuous suture is relied upon to maintain apposition of the peritoneum or fascia. Jenkins[8] found that "It was usually observed that the catgut had become untied in the fascia rather than digested in the tissues. Apparently plain catgut is acted upon by the tissues in such a way that any knot, however carefully tied, will tend to loosen up in a couple of days so that the slightest tension will permit it to untie."

Size of Suture Material.—Harvey[47] states that the suture selected must have adequate tensile strength, but that this should be determined by the task for which it is employed and not by the physique of the surgeon. The force required to occlude even major vessels is only five pounds, which is not in excess of the inherent strength of the lightest ligature, while slipping off due to pulsation can be prevented by transfixion. Tension should be borne by large removable sutures placed well back and not by the suture line as was pointed out above. The function of sutures in the wound itself is merely to approximate tissues and since, as Harvey further indicates, fascia and tendon will rarely stand more than five pounds' tension without tearing, while this much strength is afforded by C twisted silk and 00 catgut, to use, as is often done, "braided silk or No. 2 catgut in approximating wounds is as unintelligent as mooring a rowboat with a ship's cable."

To use large suture material and thus play safe has the dual disadvantage that the foreign body acts as a nidus for infection, and that in the case of absorbable material, the irritating effect of the absorbing suture on the tissues is great, even to the point of forming sterile abscesses. This may defeat the purpose of the large suture, since the greater tissue reaction excited by its size may produce more rapid digestion of the material and thus actually decrease its holding time.

Type of Suture Material.—Galen in the first century described the use of catgut and silk in surgery, although ancient writings indicate that various cords were used in ligating vessels in remote antiquity. In 1816, Physick[37] demonstrated the superiority of catgut over flax and silk due to its absorbability. About 1864, Porta[38] described the results of 600 experiments using catgut, silk, hair, and hemp as ligatures. Despite these early scattered experiments, research in the field really began with Lister,[39] who in 1869 first referred to the use of antiseptic catgut. With his work, there was initiated a tremendous interest in surgical suture material which still continues. As was natural, the trend in research was toward sterility of material with the result that now surgeons are assured that domestic catgut from the larger manufacturers is uniformly sterile.[40]

Inadequate healing resulting in wound disruption has been described regardless of whether wire, linen, silk, silkworm gut, or catgut was used. The advocates of the silk technique, as well as others, feel that

disruption is less likely to occur following use of silk than following use of catgut. Although no comparable statistics are available on this point, the majority of cases reported by Sokolov[6] were following the use of silk, but in Europe it is customary to use this material more frequently than catgut.

Jenkins says, "In general it may be said that where nonabsorbable material is used, the factors influencing disruption are primarily referable to the surgeon and his technique and the ability of the patient's tissues to hold the suture material in the face of any strain on the wound from postoperative complications or conduct until adequate healing occurs. Inherent qualities of the suture material do not enter into the problem to the extent which occurs in absorbable material."

Suture material causes foreign body tissue reaction because of its size and quantity and because of its own chemical composition. Silk has shown itself much less irritant than catgut and may be used in much finer sizes. The work of Whipple[41] and Whipple and Elliot[42] has shown the superiority of its use in clean surgical work. The experiments of Howes[43] on the strength of wounds sutured with catgut and silk have shown that the exudation reaction lasts longer with catgut, and that the full strength of the wounds is gained somewhat earlier with silk than with catgut. Fewer complications follow the use of silk, as has been shown by Shambaugh's study.[44] He found twice as many serious complications and nearly ten times as many minor ones after the use of catgut as after silk suture. This, however, does not tell the whole story since the use of silk requires a different technique of handling tissues from catgut. Silk is finer and the strands are more easily broken so that the surgeon must perforce be gentler in handling tissues and there is less tendency to tension on sutures. The knots of silk may be cut very short since they do not swell and untie like those of catgut. Because of this factor, less foreign material is left in the wound.

When catgut is used, several factors peculiar to this suture material must be considered. Kraissl[45] found in most brands of catgut foreign body inclusions and flaws possibly due to splicing the catgut, and he felt that these imperfections appreciably altered the rapidity of their loss of tensile strength as determined by digestion tests in vitro.

Furthermore, there is no doubt that in some wounds catgut disappears very rapidly, apparently as a result of specific reaction of the tissues to it. On the other hand, Jenkins[8] has shown that the rate of absorption is quite variable and does not correspond to the anticipated rate. The length of stay of catgut in a wound is uncertain and its premature absorption may lead to separation before healing is firm. Whatever the type of suture material used, it should be the finest in size that will hold the tissues in apposition. It should not have greater strength than the tissues sutured, since if tension becomes too great, the tissues will tear through. The softening and necrosis which occur

when tension develops in tightly drawn thick sutures soon render the tissues incapable of holding any suture material.

How far superior silk is to very fine catgut used in the same fashion we do not know, since catgut in sizes comparable to silk is not available. However, catgut used as carefully as silk "with the silk technique" gives much cleaner healing than when it is used in heavy grades and large quantities, as is often the case. As Fallis[46] has said, "It is evident that care in suturing is more important than the suture material used."

The most recent suggestion in regard to the effect of suture material upon healing has been that the patient may in some way have become allergic to catgut so that its presence in the recently closed wound results in an exudative reaction and too rapid absorption of the suture, allowing the wound to dehisce. This factor will be subsequently discussed at length and experiments bearing on this point will be presented.

In *summary* then, the general factors which influence wound healing are malignant disease, hypoproteinemia, vitamin C, age, metabolic diseases such as diabetes and nephritis, anemia, dehydration, and distant infection. The local factors are débridement, method of placing sutures, electrosurgery, infection, drainage, strain on the wound, the anatomic aspects of the abdominal wall, tension sutures, integrity of surgical knots, size of suture material selected, and nature of material in sutures and ligatures.

THE ROLE OF CATGUT ALLERGY IN WOUND HEALING

The question of allergic manifestations to catgut has presupposed that individuals could be rendered sensitive to catgut either through parenteral deposit of the material in the course of an earlier operation, through previous treatment with sheep serum, or through protein therapy. Reil,[48] who studied the mechanism of catgut absorption from both a physiologic and chemical point of view, states that in the condition in which catgut exists at the time of its introduction into the tissues it is incapable of being absorbed or of giving off antigenic irritative substances because the proteins contained in it are exclusively in the stable form and consequently its colloids are almost entirely present as gels. Later the proteins are rendered labile by the action of the tissue juices and the colloids appear as sols. After the necessary conditions for absorption are fulfilled, absorption proceeds through the agency of the leucocytes. Their tryptic and ereptic ferments split the proteins in succession to peptones, polypeptides, and amino acids. In this process the colloidal substances become crystalloidal. "Because the cleavage products with large molecules are at once further decomposed, all possibility of irritation of antigenic origin may be dismissed."

Although Marchesani's experiments[49] indicate that no specificity exists between sheep serum and catgut, his results are so discordant that

no final conclusions can be formulated from them. Two to three weeks after 13 guinea pigs were sensitized with sheep serum, all received, intracardially or intravenously, 0.5 c.c. to 1 c.c. of a catgut extract. While 7 animals presented symptoms which the author interpreted as evidence of anaphylaxis, 6 guinea pigs gave no symptoms whatever. Details of the preparation or the concentration of the extract are lacking in the original report, except for a single statement that the catgut was prepared from the dried intestine of sheep. In another series, 6 guinea pigs were "sensitized" with the catgut extract. No evidence, however, is presented to show that they were sensitive. Three weeks later the animals were given 1 c.c. of the extract either intracardially or intravenously. There was no reaction whatever in 5 animals, but there were symptoms suggestive of anaphylaxis in only 1 animal, and it survived. In a third series, 12 guinea pigs were "sensitized" with catgut extract, and about two weeks later were injected with sheep serum. There was no reaction in 9 animals, but death in 3. Autopsies, however, were not performed. A similarly injected control series was not described. A negative result was encountered in 4 of a total of 6 guinea pigs in which catgut was implanted intraperitoneally, and four to six weeks later they were injected with sheep serum. Marchesani states that strands of catgut buried intradermally in guinea pigs sensitized to sheep serum caused a greater leucocytic response than in normal guinea pigs.

Gratia and Gilson[50] state that fragments of catgut, either plain or iodated, implanted intraperitoneally in guinea pigs that had been sensitized to horse serum or sheep serum or both, caused an edematous, hemorrhagic, and "plastique" reaction. Frugoni,[51] however, was unable to confirm this either macroscopically or microscopically. The former authors interpreted their results as the Arthus phenomenon and suggested it as a cause of postoperative adhesions. The same result was obtained in rabbits sensitized to either horse serum, sheep serum, or catgut, after which a catgut emulsion, desiccated horse serum, and desiccated sheep serum were introduced respectively into the peritoneal cavity.

Moriconi[52] was unable to demonstrate any serologic manifestations referable to immunity in rabbits that had been subjected to the absorption of either plain or iodated catgut. Precipitin tests on their serum were completely negative. Neither was he able to produce any symptoms of general or local sensitivity in rabbits subjected to the repeated absorption of catgut. In a criticism of Moriconi's work, Kraissl[32, 45] states, "It is to be noted, however, that he was working with rabbits which are rather difficult to sensitize." In reality, rabbits are readily sensitized, while guinea pigs are sensitized with difficulty but demonstrate anaphylaxis more readily than rabbits.

Frugoni[51] was unable to demonstrate any serologic changes in the serum of rabbits that had received catgut extract intravenously or cat-

gut implanted intraperitoneally. Precipitin tests were entirely negative. Attempts to produce anaphylactic shock in guinea pigs that were sensitized with sheep serum and then injected intravenously with catgut extract were likewise negative, as had been shown previously by Moriconi.[52] Attempts to produce anaphylactic shock by the intravenous injection of sheep serum in guinea pigs that had catgut implanted in the peritoneal cavity 60 days previously were completely unsuccessful. Frugoni obtained identical reactions, both macroscopically and microscopically, when catgut was implanted intraperitoneally in control rabbits, in rabbits sensitized with sheep serum, and in those having been previously treated with catgut. The wounds healed per primam and there was no increased local reaction. His results were so completely negative that he ruled out any antigenic action of catgut.

Babcock[53] studied the macroscopic reactions of plain and chromic catgut and other suture material (silk, horse hair, dermal sutures, silver and alloy steel wire) by implanting small sections of these in the sterilized skins of 120 normal patients. Inasmuch as all materials in every patient presented a reaction with the same characteristics, limited to the site of the implantation, but some to a lesser degree, this does not prove that the reactions were allergic or anaphylactic in character.

Tripp[54] reports the case of a patient who developed asthma while convalescing from a second operation in which chromic catgut had been used. It is not stated what suture material had been employed in the first operation five years previously. The asthma, however, totally disappeared after a few weeks. He reports this as a case of catgut sensitivity, and yet no tests were made to confirm his assumption.

Kraissl[45] states, "It is possible to sensitize guinea pigs to catgut and to produce disruptions of laparotomies sutured with this material." Guinea pigs were used because "rabbits are rather difficult to sensitize." It is a well-known fact that tissue sensitivity can be produced more easily in rabbits than in other laboratory animals. On the other hand, typical anaphylactic shock can be more readily induced in the guinea pig than in other animals. "Nineteen guinea pigs were sensitized with plain and chromic catgut. This was done with intraperitoneal injections of a colloidal suspension, by burying catgut itself subcutaneously, and by closing abdominal laparotomies with catgut. In addition one was sensitized by intracardiac injection and another by repeated intradermal injections." Intradermal injections of approximately 0.1 c.c. of catgut extract containing 0.13 mg. per cent total nitrogen was used to determine sensitivity. Laparotomy incisions were closed with through-and-through bolt sutures of plain and chromic catgut. Six of the 19 incisions disrupted, 3 being sewed with plain catgut and 3 with chromic catgut; 1 of each being sensitized to the other type of catgut. Only 3 had positive skin tests, although data are lacking describing the appearance of a positive test. Five incisions disrupted between the second and fourth postoperative days, and 1 on

the eighth postoperative day, and 4 healed abnormally. None of the incisions in 6 control guinea pigs disrupted, but 1 healed abnormally.

From this experiment several sources of criticism are readily discernible. No mention is made of any aseptic technique employed during the execution of the laparotomies. That the incisions were infected is obvious from the photographs which are submitted as evidence of disruption. No mention is made of the appearance of the wounds prior to disruption. Secondary closures were apparently not attempted. No attempt was made to produce anaphylactic shock in the sensitized animals, neither were any serologic tests performed to test for the formation of precipitins.[55]

In a later study,[56] which includes the experiment previously described, Kraissl found that of 28 guinea pigs sensitized to plain catgut, 10 disrupted their incisions: 1 on the first postoperative day, 2 on the second, 1 on the third, 4 on the fourth, 1 on the seventh, and 1 on the eighth postoperative day. Nine healed abnormally, while 9 healed normally. In a group of 16 guinea pigs sensitized to chromic catgut, 5 disrupted between the second and sixth postoperative day, 4 healed abnormally, and 7 healed normally. Of 8 animals sensitized to chromic acid, 2 disrupted and 3 healed abnormally, while of 26 controls only 1 healed abnormally.

Langston,[69] impressed with the frequency of poor healing in third stage thoracoplasty wounds among persons with wounds closed with catgut in two previous stages, prepared a catgut extract with which he performed skin tests. Twelve per cent of the surgical patients had positive cutaneous tests, although the only description of a positive test is that it was maximal in fifteen to twenty minutes and faded after forty-five minues. After two thoracoplasties using catgut, 70 per cent of the persons tested had positive skin tests. The evidence of catgut sensitivity is rendered inconclusive, however, by failure of attempts to demonstrate passive transfer of sensitivity and absence of precipitins from blood serum and wound fluid in "sensitive" persons.

Catgut consists of the submucosa of the small intestine of sheep. In its manufacture, the intestine is split longitudinally usually into three strips. The mucosa is then scraped off from the inner side, then the serosa and the two muscular layers are scraped off from the outer side, thus leaving only the submucosa. The strips of submucosa are then subjected to alkaline baths for the purpose of neutralizing any acid or toxic substance which may have been embedded in them as a result of the digestive process. Titration tests are then applied to prove that the tissue is neutral in reaction. The strips of submucosa are then spun into a cord called *catgut*, which is chemically pure collagen. According to Bodansky,[57] connective tissue contains about 60 per cent water and 40 per cent solids. Of the latter, about 0.5 per cent consists of inorganic matter. The principal organic constituent of fibrous tissue is the albuminoid collagen, which composes about 32 per cent of the tissue, the

remaining 6.7 per cent being made of elastin, an albuminoid, ether soluble lipids, and nonprotein constituents. Upon hydrolysis, collagen is transformed into gelatin, which is interesting because of the complete absence of three amino acids, tryptophan, cystine, and tyrosine. A fourth amino acid, histidine, is present only in exceedingly small amounts.[58] Ziegler and Clark[59] state that the x-ray diffraction pattern of the catgut ligature is quite similar to that of gelatin and collagen. Gelatin, in so far as these authors are aware, does not give typical immunologic reactions. Silk, silkworm gut, women's hair, and horse's hair contain much cystine and glycocol.[48]

Human tissues absorb catgut by means of tryptic ferments of leucocytic origin. These ferments do not leave intact any albuminoid residue which could act in an antigenic capacity, as has been shown by Reil.[48] After catgut is rendered soluble, it is no longer collagen but amino acid. Frugoni[51] demonstrated by chemical analysis that the substances present in a catgut extract are not albumins but albumoses which are without antigenic power and, therefore, incapable of causing sensitization.

EXPERIMENTAL STUDIES

The present experiments* were carried out in order to determine whether domestic catgut could produce any evidence of sensitivity, either general or local, in either rabbits or guinea pigs. It was decided at the outset to use a standard brand of boilable catgut, selected at random for the surgical supply rooms of the Johns Hopkins Hospital.

Sixty rabbits and 80 guinea pigs have been used in the experiments here reported. In the first experiment, 12 rabbits and 12 guinea pigs were subjected to six implants of plain catgut at intervals of one month. The procedure was as follows. The day prior to operation the entire abdomen and flanks of the animal were clipped and shaved. Under ether anesthesia, a wide operative field was cleaned with ether, iodine, and alcohol, after which the operative field was appropriately draped with sterile towels. Rigid asepsis was observed throughout. The instruments and ampoules of catgut were sterilized by boiling for 10 minutes. A paramedian incision 3 to 4 cm. in length was made through the skin and subcutaneous tissue. The muscle was then divided by blunt dissection, and the peritoneum opened the full length of the incision. The catgut before its insertion was softened in physiologic salt solution. A continuous suture of plain No. 0 catgut was used to close the peritoneum. Interrupted sutures of No. 0 catgut were used to close the muscle and skin respectively. Square knots were tied and cut moderately close. Every effort was made to reproduce the technique employed in the operating room, except for the fact that no gauze dressing was applied over the incision. Occasionally, however, the incision was sealed with collodion. One month later, the same process was repeated, using the back of the

*Some of these experiments were previously published in the Bulletin of the Johns Hopkins Hospital[60] with whose permission they are here presented.

animal. Here, likewise, a paramedian incision was made, and carried down through the heavy musculature of the back. The muscle and fascia were approximated with interrupted sutures of plain No. 0 catgut, the skin edges being closed on six occasions at intervals of one month, alternating the abdomen with the back for the operative site.

The second experiment, using 12 rabbits and 12 guinea pigs, was similar to the one above except for the fact that chromic No. 0 catgut of the sizes indicated was employed.

Lest it be said that an insufficient quantity of catgut had been implanted in the previous experiments, even though an amount equivalent to that employed in routine surgical procedures was used, a third experiment was performed in which, instead of simply making incisions and closing them with plain or chromic catgut respectively, in the present experiment two or three strands of catgut 3 to 4 cm. in length were buried either intramuscularly in the back or subcutaneously in the abdominal wall. In 6 rabbits and 6 guinea pigs, two or three strands of plain No. 1 catgut were buried on six occasions at intervals of one month beginning with the back and alternating with the abdomen. The incisions were closed with interrupted sutures of plain No. 0 catgut. A similar number of animals was subjected to the absorption of two or three strands of No. 1 chromic catgut at intervals, 30 days for one month. The incisions were closed with chromic catgut in the manner previously outlined. Where plain catgut was buried, plain catgut was used to close the wounds and vice versa.

RESULTS

In both rabbits and guinea pigs using either plain or chromic catgut, the incision in every instance healed per primam following each operation. There was no evidence whatever of any increased local reaction as compared with normals. There were no disruptions, no infections, and no evidence of either local or general sensitivity. Prior to each operation in the rabbits, precipitin tests for antibody production were carried out. In addition, intradermal tests in both rabbits and guinea pigs with suitable controls were performed, by injecting 0.1 c.c. of a catgut extract. These, also, were completely negative.

The catgut extract was made in the following manner. Ten skeins of plain No. 3 catgut were pulverized by grinding in an Arabian coffee grinder. After placing the catgut powder in a heavy liter bottle, 500 c.c. of sterile physiologic saline solution and pyrex chips were added. The container was then placed in a mechanical shaker for 4 hours. This yielded a colloidal suspension of catgut particles in a saline vehicle. The suspension was then placed in a vacuum dryer; 0.1 Gm. of the powder thus obtained was placed in glass ampoules covered with xylene and the ampoules sealed in a flame. The tubes were then autoclaved under oil for one hour. This is the process generally employed by manufacturers in the sterilization of catgut. Using sterile

technique, the tops of the ampoules were then removed and a cotton plug inserted, thus allowing the xylene to evaporate. This completed, 5 c.c. of sterile physiologic saline solution were then added to each tube. This dissolved the greater portion of the catgut powder. The resulting clear, sterile supernatant fluid was then withdrawn and placed in sterile serum bottles or tubes. Total nitrogen determinations by the micro-Kjeldahl method revealed not less than 50 mg. per cent of this element.

In another experiment, 3 rabbits had three strands of sterile, chemically pure catgut implanted intramuscularly in the back on three occasions at intervals of one month; 3 rabbits had 10 to 12 gr. of chemically pure powdered catgut deposited in the peritoneal cavity on three occasions at monthly intervals through an incision 4 to 5 cm. in length; 3 had 10 to 12 gr. of powdered commercial plain catgut implanted in a similar manner; 3 had 10 to 12 gr. of powdered chromic catgut implanted intraperitoneally; 3 rabbits had a skein of plain No. 0 catgut buried intraperitoneally on three successive months, and 3 rabbits had a skein of No. 0 chromic catgut implanted intraperitoneally on three occasions. In each instance, the incision was closed in layers with interrupted sutures, No. 0 catgut, of the type implanted.

Never was there any evidence of either a local or general reaction, and the incisions in each instance healed per primam. It was interesting to find that at the end of a month no evidence whatever could be found of the plain catgut or the chemically pure catgut, regardless of the form in which it was deposited. In those animals that received the skein of chromic catgut, on only two occasions was it possible to find any vestige of the skein. In these the remnants were found with difficulty as a tiny white mass embedded in the gastrocolic omentum. Microscopic section revealed these to be almost solid masses of leucocytes and macrophages, and it was impossible to identify anything discernible as catgut. Inasmuch as no trace of the catgut could be found after one month, the peritoneal cavities were examined thereafter in 10 to 12 days after the second catgut implant. At this time the powdered catgut could be recognized as minute flecks on the surface of the intestine which was slightly reddened. The reaction, however, was no more marked than that found in 3 similarly treated control animals. The animals in which the skein of catgut had been deposited, either plain or chromic, showed even less reaction, limited to the immediate vicinity of the catgut implant, i.e., either between loops of small intestine or in the gastrocolic ligament. The plain catgut was found as a mass of rather friable white material, while the contours of the chromic skeins were still well differentiated, and the strands still bore considerable tensile strength. By the end of the third week only traces of the powdered catgut could be found between the loops of adherent intestine and there was no longer any reaction whatever. It should be made clear that there were no adhesions but simply a coherence be-

tween adjacent loops of intestine, and limited only to the site of the catgut implant. The skeins of plain catgut presented the same appearance except for being considerably smaller in size than after the second week. The chromic catgut skeins at the end of the third week appeared as a mass of friable white material. And as was previously stated, at the end of four weeks no trace whatever of the plain catgut could be found, while in 2 instances remnants of chromic catgut skeins were recognized as tiny, white friable masses.

One month after the third deposit of catgut, the peritoneal cavities were again examined. Numerous friable adhesions between adjacent loops of bowel were found limited to the site of the catgut deposits. Although some of the animals have been sacrificed in the interim, 6 of the rabbits are still living and appear perfectly normal more than a year after the last catgut had been implanted. Hence, we are unable to confirm the supposition of Gratia and Gilson[50] that catgut causes any more adhesions than other suture materials, or that catgut is a prominent cause of postoperative adhesions. Precipitin tests performed at monthly intervals on the serum of the rabbits for antibody production were entirely negative. Intradermal tests for local sensitivity were also negative.

To test for anaphylaxis, 42 guinea pigs were used. Twelve were injected intravenously in the jugular vein with 1 c.c. of our catgut extract; 12 were injected intravenously with 1 c.c. of Kraissl's extract of plain catgut;* and 12 were injected intravenously with 1 c.c. of Kraissl's chromic catgut extract;* 6 guinea pigs were used as controls in which saline solution was injected. After three to four weeks, all animals were again injected intravenously with 1 c.c. of the prescribed extract. For the intravenous injections, the jugular vein was exposed without anesthesia, extreme caution being exercised to avoid bleeding. Not a single reaction was encountered.

To determine conclusively whether any increased local reaction occurred around a single intradermal strand of catgut in animals submitted to the previous absorption of catgut, either plain or chromic, 6 rabbits and 6 guinea pigs had laparotomies performed and two or three strands of plain No. 0 catgut buried subcutaneously. The incision was closed in layers using plain No. 0 catgut. Six rabbits and 6 guinea pigs were similarly treated burying two or three strands of chromic catgut. Three rabbits and 3 guinea pigs were injected intravenously with 1 c.c. of the catgut extract. After one month, using rigid asepsis, a strand of either No. 0 or 00 catgut about 2 cm. in length was inserted intracutaneously, using an atraumatic needle, in each flank. In those animals in which plain catgut had been previously buried, the intradermal implant was likewise of plain catgut, and vice versa. The sites of implant were observed macroscopically at the end of 24 to 48 hours respectively, and the sections of skin containing the catgut implant

*Extracts furnished by Dr. C. J. Kraissl.

were removed for microscopic study. The same procedure was performed in 6 normal guinea pigs and 6 normal rabbits.

The site of the catgut implant was always discernible as a small erythematous streak. Never was there any greater macroscopic reaction in those animals that had previously been treated with catgut than in untreated controls. Microscopic sections revealed in both the previously treated and the normal controls a positive chemotactic leucocytic response, but in no instance was the leucocytic emigration greater in the rabbits or guinea pigs which had been previously treated with catgut as compared with normal control animals. (See Figs. 1 to 6.)

DISRUPTION OF ABDOMINAL WOUNDS

There has been no unanimity of opinion as to what roles the various factors influencing wound healing play in disruption of abdominal wounds. The following is a summary of the opinions of the authors who have studied the problems.

Freeman[61] believes that the primary cause is insecure peritoneal closure, permitting the edematous omentum to act as a wedge and produce separation of the peritoneum and then of the muscle and fascia. Starr and Nason[62] also believe the omental wedge to be the primary cause, but they list several factors which they believe important in contributing to disruption, namely, carcinoma, retching and straining, hyperventilation, and increased intra-abdominal pressure. Sokolov,[6] after a study of 725 cases reported by 187 surgeons, reached the conclusion that since disruption of wounds seemed to be more frequent in the early part of the year, it was to be explained on the basis of general fatigue and relative vitamin C deficiency during the winter months. He found that even the use of silk in place of catgut does not prevent wound disruption. He states: "The principal causative factor is always the patient's tissue qualities and their reduced tonus as affected by the disease." Erdmann[63] ascribes disruption of wounds to "tissue hunger" with resulting rapid digestion and absorption of catgut. He has noted the condition chiefly in cases of anemia due to such things as tuberculosis, carcinoma, hemorrhage, infections, and malignancies of the female pelvic organs. Meleny and Howes[31] stressed the fact that care in suturing must be concentrated on the peritoneum and posterior sheath, together with the use of retention sutures. Colp[24] believes that the crux of the problem rests in the failure of the regenerative powers of the tissues to promote firm healing. He states: "The primary disease undoubtedly is the most important feature underlying the etiology of wound rupture. While it is true that rupture of the abdominal wall may occur in any disease affecting the peritoneum and its contents, it appears to be associated more frequently with some diseases than with others. It would seem logical to suppose that illnesses of a protracted nature attended by emaciation, anemia, cachexia, and weakness, and those of acute and chronic intoxications associated

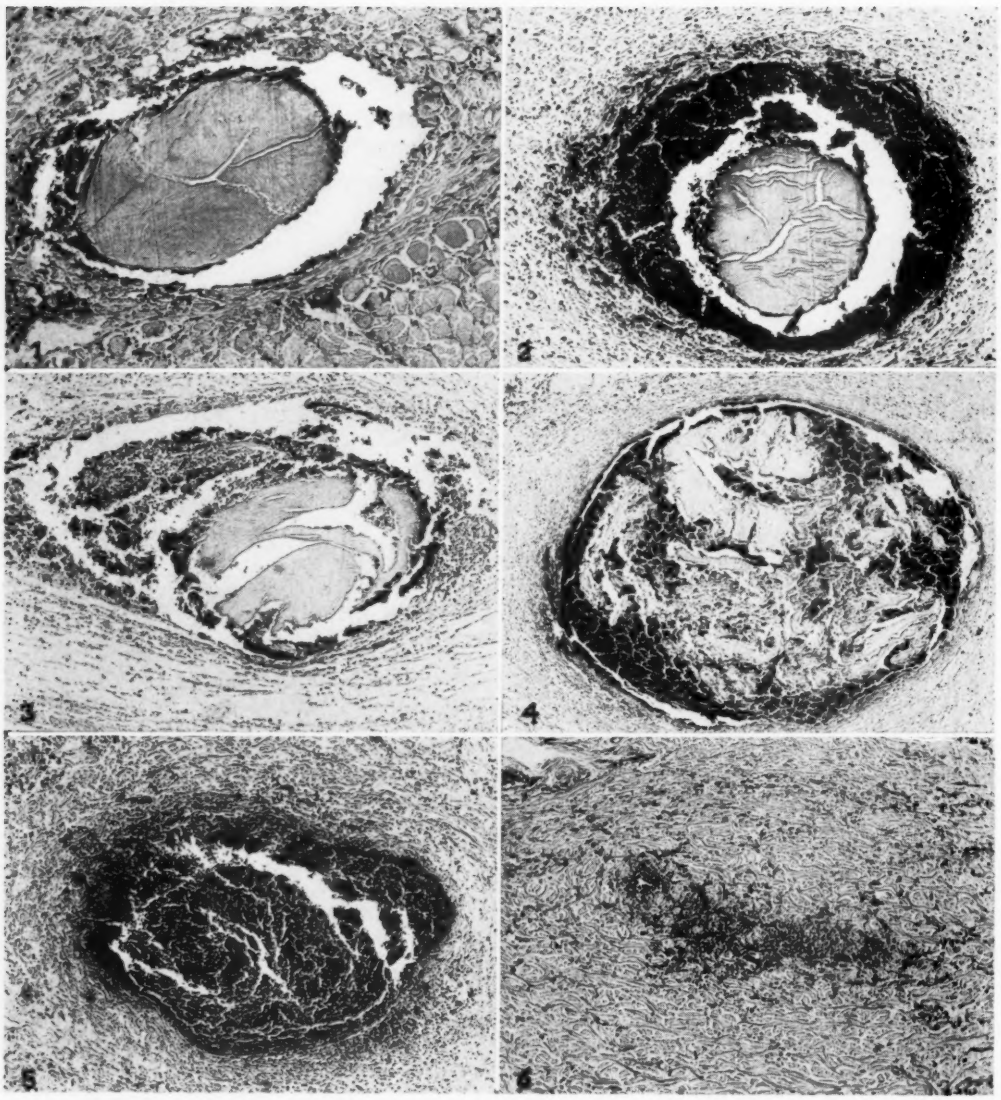

Fig. 1.—Microscopic section of strand of plain No. 1 catgut implanted subcutaneously into the back of a rabbit 48 hours previously. The catgut was inserted with an atraumatic needle using sterile technique. There is beginning leucocytic proliferation in response to the implantation of a foreign body.

Fig. 2.—Microscopic section of strand of plain No. 1 catgut implanted 5 days previously into the back of a rabbit. The leucocytic response is marked, filling the dead space caused by the needle. Leucocytes have begun to invade the twisted strand of catgut.

Fig. 3.—Photomicrograph of strand of catgut buried 12 days previously. The leucocytic response has subsided considerably but the leucocytes have invaded the interior of the strand which is now beginning to fragment. The catgut strand at this stage still possesses considerable tensile strength.

Fig. 4.—Microscopic section of strand of catgut implanted 21 days previously. The invading leucocytes together with their tryptic and eryptic ferments have caused complete fragmentation and partial digestion of the catgut strand. At this stage the strand of catgut possesses no tensile strength.

Fig. 5.—Photomicrograph of catgut strand buried 30 days previously. It has undergone complete digestion. The leucocytic response is still marked.

Fig. 6.—Microscopic section taken at the level of catgut implant 40 days previously. The catgut strand has been completely digested, the leucocytic response is disappearing, and the tissues are approaching normal.

with long bouts of temperature, might devitalize the individual sufficiently to interfere with the reparative powers of the tissues and wound healing. Malignant tumors with their undeniable debilitating effect on the body are responsible for most wound disruptions. Certain benign growths like uterine fibroids are often attended with harmful systemic affections, particularly secondary anemia, definitely impairing proper metabolism.''

White[27] says that predisposing causes are senility, decrepitude, malignancy, jaundice, and a peculiar body tissue function that dissolves catgut earlier than usual. Also, that the exciting causes are constant coughing, hiccoughing, straining, distension, undue abdominal strain, and infection. Heyd[64] recommends as preventive measures (a) complete hemostasis of the wound; (b) relaxation of the abdominal walls when closure is being made; (c) avoidance of undue trauma; (d) elimination of dead space which favors collection of serum; (e) absolutely aseptic technique; and (f) accurate coaptation of the peritoneum. Harvey[65] believes that the constitutional or general condition of the patient, such as the presence of malnutrition, and particularly anemia, may lead to weakening of the wound. He ascribes three essential reasons for disruption of wounds: (1) failure to close properly the posterior rectus sheath; (2) the presence of foreign material in the wound, including infection or accumulation of serum in dead spaces as a result of inaccurate apposition of the tissues; and (3) the use of too large sized catgut in too large a quantity, which thus acts as foreign material. Baldwin[66] stresses the importance in any abdominal case of re-enforcing the dressings by a scultetus or many-tailed binder applied snugly around the abdomen. He also points out the value of using stay sutures, which he advocates leaving in place long enough to prolong the period of maintenance of tissue holding, and thus insure firm union. He frankly admits that he encountered wound disruption when he removed the stay sutures after 7 days; also when the sutures were removed after 10 days, and again when he removed the sutures at the end of 12 days. However, he then adopted the policy of leaving the stay sutures in place for 14 full days and supporting the abdomen by a firm many-tailed binder so that it can be properly adjusted and there will be no slipping. Even after the removal of the stay sutures at the end of 2 weeks, the abdominal binder is reapplied and kept in place for another week. During more than 35 years since adopting this technique and during which period he has performed 16,465 abdominal operations, not one of these patients of Baldwin's developed wound disruption or postoperative hernias.

Singleton[67] recommends the use of a modified Sloan transverse incision in the upper abdomen, because it is anatomic in that no important nerves or blood vessels are cut and the muscles and fascia are separated in the direction of their fibers. Such a wound, he states,

may be closed without tension; and in a series of nearly 300 operations in which he has used this technique, there have been no disruptions and no postoperative hernias. Maes, Boyce, and McFetridge[30] state that regardless of age, sex, personal equation, operative risk, underlying pathology, anesthesia, or any similar consideration, wound disruption occurs in all cases because of one fundamental consideration: some interference with the process of wound healing. They conclude that rupture is possible with any type of suture material and in any type of closure. They believe that catgut used with the "silk technique" is as safe as silk, and they question the wisdom of advising the general use of silk. Milbert[26] reviewed 1,560 laparotomies to determine the incidence of disruption of abdominal wounds. He found 20 cases of partial or complete separation of the abdominal wall in the fourth, fifth, and sixth decades of life. Its incidence was especially high in cases of chronic infection and cases of malignancy with cachexia and anemia. Of the 20 cases of disruption, drainage was established in 9. He emphasizes the importance of intra-abdominal pressure as a causative factor in wound disruption, especially the constant or explosive type of increased intra-abdominal pressure which is associated with coughing. He concludes that dehydration, malnutrition, and obesity favor the disruption of wounds, and emphasizes the importance at operation of strict asepsis, limitation of tissue trauma to the minimum, and accurate approximation of the severed tissues. He states that the anesthesia must give sufficient relaxation of the muscles to permit good closure. Abdominal binders should be used as their benefits overbalance their disadvantages.

Over a period of six consecutive years in which spinal anesthesia was used for more than 7,800 laparotomies, Koster and Kasman[29] encountered wound disruption in only 0.22 per cent of their cases. All wounds were closed with continuous sutures, No. 2 plain catgut for the peritoneum and No. 2 chromic catgut for the fascia, the muscle not being sutured separately. They find that spinal anesthesia affords maximal relaxation of the tissues, and thereby facilitates the operative procedure so that the tissues receive the least amount of trauma. These authors conclude that (1) abdominal operations should be performed aseptically with maximum wall relaxation; (2) undue trauma should be avoided; (3) complete hemostasis should be attained; (4) accurate coaptation of the layers of the wall without dead space should be secured; (5) postoperative disruptive forces, as cough, vomiting, and hiccough, should be strenuously combated; (6) wounds should be inspected for a possible subcutaneous separation particularly before the sutures are removed. The attention given these details will affect the incidence of disruption. Jenkins[8] has pointed out that the inherent weakness of the posterior sheath and the prevalent use of plain catgut, which lasts only five to six days under any condition, for closure of

this layer, are undoubtedly factors which are responsible for the frequency of disruption in the upper abdomen in the American cases. He also states that disruptions have been found to occur regardless of whether wire, linen, silk, silkworm, or catgut is used.

Kraissl and co-workers[56] analyzed 30 cases in which the patients survived wound disruption at the Presbyterian Hospital since 1930. No mention is made of wound disruptions occurring in cases in which silk or other suture materials were used. Of these 30 cases, 24 wounds were infected, and only 4 were not complicated by distention, cough, hiccough, pneumonia, vomiting, acute intestinal obstruction, etc. Kraissl states that "a history of allergy or a previous operation increases the likelihood of an individual being sensitive to catgut." "All 5 cases which gave a history of allergy showed a positive skin test to one or more of the extracts," i.e., plain, chromic, or chromic acid extract. "Twelve of the whole group had a previous operation and 7 of these gave a positive reaction. Of the 18 which gave no history of operation, 12 had a positive skin test indicating that this factor was of little importance in this group. However, it may be possible that the reaction to the catgut causing the disruption may have desensitized the individual resulting in a negative response to the skin test."

WOUND DISRUPTION AT THE JOHNS HOPKINS HOSPITAL

Thirty-five cases of abdominal wound disruption have occurred on the surgical, gynecological and obstetrical services of the Johns Hopkins Hospital since January, 1937, a period of almost 7 years. Catgut was used for closure in 14 cases, silk in 19 cases, and steel wire in 2 cases. It should be made clear that this proportion is in no way representative of the usage of either type of suture material in this institution, for silk is used almost exclusively on the surgical service, while catgut is preferred on the gynecological and obstetrical services. Of these 35 cases of abdominal wound disruption, 8 had a previous abdominal operation, 7 of which had been performed in this hospital, catgut being used for closure in 4 instances and silk in 3 cases. The interval between the first and the second operation varied between 3 and 15 years. Wound healing at the time of the first operation is said to have proceeded in a normal manner. Only 9 of the 35 patients in whom wound disruption occurred are said to have been in good physical condition at the time of operation. There was gross contamination of the peritoneal cavity in 29 instances at the time of the original operation, and of these, the wounds in 15 cases were grossly infected at the time of the disruption. The main causative organism was *Bacillus coli*. Drainage was established in 6 cases, and retention sutures were employed in 16 cases. The age of the patients ranged between 20 and 80 years; 22 cases (63 per cent) occurring in patients over 50 years of age (see Table I).

TABLE I

AGE PERIOD	YEARS 20-29	YEARS 30-39	YEARS 40-49	YEARS 50-59	YEARS 60-69	YEARS 70-79	TOTAL
Number of disruptions	6	3	4	9	11	2	35

The greatest number of disruptions occurred following gastric resection for malignant disease of the stomach and duodenum, and following pelvic operations, including cesarean section. The 6 patients in whom disruption occurred (in patients under 30 years of age) were operated upon following gunshot wounds of the abdomen or cesarean section (see Table II).

TABLE II

PRIMARY DISEASE	DISRUPTIONS
Malignant disease of stomach and duodenum	8
Benign ulcers of stomach and duodenum	2
Pelvic operation including cesarean section	8
Gunshot wounds of abdomen	4
Intestinal obstruction	3
Carcinoma of pancreas	1
Exploration of common duct	2
Diverticulitis of colon	2
Omentopexy for cirrhosis	1
Neoplasm of large intestine	4

In our series of 35 cases, 16 instances of abdominal wound disruption occurred on the seventh postoperative day, 7 cases each on the sixth and eighth postoperative day respectively, making a total of 30 cases (85 per cent) in which disruption occurred in the quiescent phase or "lag period"—extending to the eighth postoperative day (see Table III). These observations confirm those of Harvey and Howes[11] who found that the first 6 or 7 days of wound repair were the critical days.

TABLE III

POSTOPERATIVE DAY OF WOUND DISRUPTION	4TH	5TH	6TH	7TH	8TH	12TH	13TH	TOTAL
Number of cases	1	2	7	16	7	1	1	35

Incisions.—As evidence that disruption occurs through various types of incisions, 10 disruptions occurred through a lower midline incision, 8 through the upper midline, 9 through a right rectus, 7 through a left rectus, and 1 through a subcostal transverse incision. In 21 instances, the peritoneum or posterior sheath of the rectus was closed with continuous sutures of catgut. As stated previously, there was gross contamination of the peritoneal cavity in 29 instances, and 15 were grossly infected at the time of the disruption. Drainage was established in 6 cases and retention sutures were employed in 16.

Anesthesia.—Gas-oxygen-ether anesthesia was used in the primary operation in 27 patients, spinal anesthesia being used in 6 patients, while sodium pentothal and local infiltration of procaine were each used in a single case.

Secondary Closure.—Secondary closure of the disrupted wound was performed as soon as possible after the disruption. Except in 4 instances, catgut supplemented with retention sutures was used for the secondary closure. Death occurred as a result of the disruption in only 2 instances, and 1 of these patients died with generalized peritonitis, the causative factor in the disruption of the wound.

CLINICAL STUDIES

We have had an opportunity to test for local catgut sensitivity in each of these 35 cases of abdominal wound disruption within a relatively short period after the disruption took place, regardless of the suture material used either in the operation or for closure of the abdominal wall. In 10 of the 19 cases in which silk was used for closure of the abdominal wall, catgut was used in some phase of the operation. Each patient was injected intradermally on the volar surface of the forearm with 0.1 c.c. of Kraissl's plain and chromic catgut extracts. Similar quantities of extract diluted 1 to 10 were injected intracutaneously in the opposite forearm. The tests, performed within a short period after the disruption, were negative. Furthermore, we have tested 100 patients preoperatively in a similar manner, likewise with negative results. The sites of inoculation were observed constantly for two hours and at daily intervals for several days. These same patients were again tested 3 to 4 weeks after operation, when it was assumed that the greater part of the catgut had been absorbed. These tests were completely negative.

From our analysis and a careful review of the literature, one can definitely state that disruptions occur regardless of the suture material used. Disruption in each instance was due to the markedly increased intra-abdominal pressure, either of the constant type resulting from ileus, peritonitis, etc., or more especially from the violent explosive type caused by sneezing, coughing, hiccoughing, vomiting, retching, or straining. There was no evidence whatever of any increased local or general reaction. Disruption in 5 instances, in conjunction with the increased intra-abdominal pressure, might possibly have been due to insecure peritoneal closure, permitting the omentum or a loop of intestine to act as a wedge producing separation of the peritoneum and then of the muscle and fascia. It seems not unlikely that even in these 5 instances had not the increased intra-abdominal pressure been present, the omentum would never have herniated, and disruption would not have occurred. Although nonabsorbable retention sutures will not necessarily prevent disruption, they will give added support, and will prevent evisceration.

In not a single instance was there anything to suggest an increased local or general reaction. Inasmuch as the secondary closures were performed with catgut, supplemented with retention sutures, except

in 4 instances, and with healing proceeding in a normal fashion, one can disregard the supposition of catgut allergy as a cause of postoperative wound disruption.

CONCLUSIONS

From a consideration of the experiments performed, the cases of wound disruption analyzed, and the literature reviewed, one arrives at certain conclusions: (1) It was impossible for us to sensitize either guinea pigs or rabbits to commercial catgut or to an extract prepared from catgut. (2) No evidence of either local sensitivity or general reactions could be elicited in guinea pigs or rabbits subjected to the previous absorption of catgut. (3) It was impossible to produce anaphylactic shock by the intravenous injection of a catgut extract into guinea pigs that had been previously treated with either catgut or catgut extract. (4) Serologic tests for antibody production in previously treated animals were negative. (5) No disruptions occurred in either rabbits or guinea pigs which had been previously treated with catgut. (6) Although catgut implanted intradermally in both rabbits and guinea pigs causes an inflammatory response, the leucocytic emigration is no greater in those animals that had been previously treated with catgut or catgut extract. Therefore, one can finally conclude that although catgut, just as any other suture material, acts as a foreign body and causes a leucocytic response, it does not act as an antigen, nor is it capable of producing antigenic irritative phenomena. (7) Of 35 cases of postoperative wound disruption analyzed, the primary cause of the disruption was found to be markedly increased intra-abdominal pressure, and there was no evidence whatever of so-called catgut allergy. Disruptions occur regardless of the suture material employed, principally in the fifth, sixth, and seventh decades in patients affected with malignant tumors.

It is in no sense the intent of the present article to imply that catgut should be used in preference to silk as a suture material. The experiments bear simply on the question of hypersensitivity to catgut and they indicate that the use of catgut carries no danger referable to hypersensitivity to this material.

REFERENCES

1. Brehauer, J.: Three Cases of Rupture of the Abdominal Wall, Am. Gynaec. & Obst. J. **14**: 324, 1899.
2. Madelung, O.: Ueber den postoperativen Vorfall von Baucheingeweiden, Arch. f. klin. Chir. **77**: 347, 1905.
3. Ries, E.: On Postoperative Separation of Laparotomy Wounds, Am. J. Obst. **60**: 569, 1909.
4. Holtermann, C.: Ueber postoperative Dehiszenz frischer Laparotomiewunden mit Vorfall von Bauchhöleninhalt, Zentralbl. f. Gynäk. **49**: 213, 1925.
5. Shipley, A. M.: Broken-Down Abdominal Incisions. A Method of Closure, Ann. Surg. **82**: 542, 1925.
6. Sokolov, S.: Postoperative Rupture of Abdominal Wounds With Protrusion or Prolapse of the Viscera, Vestnik khir. **65**: 219, 1931.

7. Carrel, A.: Process of Wound Healing, Proc. Inst. Med. Chicago **8**: 62, 1930.
8. Jenkins, H. P.: Clinical Study of Catgut in Relation to Abdominal Wound Disruption, Surg., Gynec. & Obst. **64**: 648, 1937.
9. Clark, A. H.: The Effect of Diet on the Healing of Wounds, Bull. Johns Hopkins Hosp. **30**: 117, 1919.
10. Thompson, W. D., Ravdin, J. S., and Frank, J. L.: The Effect of Hypoproteinemia on Wound Disruption, Arch. Surg. **36**: 500, 1938.
Thompson, W. D., Ravdin, J. S., Rhoades, J. E., and Frank, J. L.: Use of Lyophile Plasma in the Correction of Hypoproteinemia and Prevention of Wound Disruption, Arch. Surg. **36**: 508, 1938.
11. Harvey, S. C., and Howes, E. L.: The Effect of High Protein Diet on the Velocity of Growth of Fibroblasts in the Healing Wound, Ann. Surg. **91**: 641, 1930.
12. Howes, E. L., Sooy, J. W., and Harvey, S. C.: The Healing of Wounds as Determined by Their Tensile Strength, J. A. M. A. **92**: 42, 1929.
13. DuMourtier, J. J.: Resistance of Healing Wounds to Infection, Surg., Gynec. & Obst. **56**: 762, 1933.
14. Lanman, T. H., and Ingalls, T. H.: Vitamin C Deficiency and Wound Healing; Experimental and Clinical Study, Ann. Surg. **105**: 616, 1937.
15. Taffel, M., and Harvey, S. C.: Effect of Absolute and Partial Vitamin C Deficiency on Healing of Wounds, Proc. Soc. Exper. Biol. & Med. **38**: 518, 1938.
16. Metheny, D.: Nutritional Deficiencies Complicating Surgery of the Gastrointestinal Tract, Northwest Med. **37**: 349, 1938.
17. Lauber, H. J., and Rosenfeld, W.: Histologische Untersuchungen über das Verhalten des Vitamins C in den verschiedenen Organen während der Wundheilung, Klin. Wchnschr. **17**: 1587, 1938.
18. Mason, M. L.: Wound Healing, Internat. Abstr. Surg. **69**: 303, 1939.
19. Anderson, D. P., Jr.: Problem of Wound Healing: Effect of Local Antiseptic Agents on Infected Wounds, Ann. Surg. **108**: 918, 1938.
20. Koster, H., and Kasman, L. P.: Relation of Serum Protein to Well Healed and to Disrupted Wounds, Arch. Surg. **45**: 776, 1942.
21. Meleny, F. L.: Infection in Clean Operative Wounds; Nine-Year Study, Surg., Gynec. & Obst. **60**: 264, 1935.
22. Ives, H. R., Jr., and Hirschfield, J. W.: Bacterial Flora of Clean Surgical Wounds, Ann. Surg. **107**: 607, 1938.
23. Howes, E. L., and Harvey, S. C.: The Strength of the Healing Wound in Relation to the Holding Strength of the Catgut Suture, New England J. Med. **200**: 1285, 1929.
24. Colp, R.: Disruption of Abdominal Wounds, Ann. Surg. **99**: 14, 1934.
25. Glasser, S. T.: Evisceration and Avulsion of Abdominal Wounds, Am. J. Surg. **32**: 63, 1936.
26. Milbert, A. H.: A Study of Disruption of Abdominal Wounds, Arch. Surg. **31**: 86, 1935.
27. White, W. C.: Disruption of Abdominal Wounds, Ann. Surg. **99**: 34, 1934.
28. Grace, R. V.: Disruption of Abdominal Wounds, Ann. Surg. **99**: 28, 1934.
29. Koster, H., and Kasman, L. P.: Wound Disruption, Am. J. Surg. **31**: 537, 1936.
30. Maes, U., Boyce, F. F., and McFetridge, E. M.: Postoperative Evisceration, Ann. Surg. **100**: 968, 1934.
31. Meleny, F. L., and Howes, E. L.: The Disruption of Abdominal Wounds With Protrusion of Viscera, Ann. Surg. **99**: 5, 1934.
32. Kraissl, C. J.: Suture Material: Review of Recent Literature, Internat. Abstr. Surg. **62**: 417, 1936, in Surg., Gynec. & Obst., 1936.
33. Taylor, F. W.: Surgical Knots, Ann. Surg. **107**: 458, 1938.
Taylor, F. W.: Surgical Knots and Sutures, SURGERY **5**: 498, 1939.
34. Ellis, J. D.: Rate of Healing of Electrosurgical Wounds as Expressed by Tensile Strength, J. A. M. A. **96**: 16, 1931.
35. Magyary, G.: Ueber die Wundheilung nach elektrischen Operationen, Arch. f. klin. Chir. **169**: 737, 1932.
36. Hauberrisser, E.: Zur Wundheilung bei Anwendung des Hochfrequenzschnittes. Unter besonderer Berücksichtigung der Mund-, Kiefer-, und Gesichtschirurgie, Beitr. z. klin. Chir. **153**: 257, 1931.
37. Physick, P. S.: Eclect. Rep. & Anal. Rev. **6**: 389, 1816.
38. Porta, L.: Delle alterazioni patologiche delle arterie per la legatura e la torsione, esperienze ed osservazioni., Milan, 1864, p. 40.
39. Lister, J.: Observation on Ligatures of Arteries on the Antiseptic System, Lancet **1**: 451, 1869.
40. Brewer, J. H.: The Present Status of Sterility of Catgut Sutures on the American Market, J. A. M. A. **108**: 722, 1937.

41. Whipple, A. O.: The Use of Silk in the Repair of Clean Wounds, Ann. Surg. **98**: 662, 1933.
42. Whipple, A. O., and Elliot, R. E. H., Jr.: The Repair of Abdominal Incisions, Ann. Surg. **108**: 741, 1938.
43. Howes, E. L.: Strength of Wounds Sutured With Catgut and Silk, Surg., Gynec. & Obst. **57**: 309, 1933.
44. Shambaugh, P.: Postoperative Wound Complications. Clinical Study With Special Reference to Use of Silk, Surg., Gynec. & Obst. **64**: 765, 1937.
45. Kraissl, C. J.: Intrinsic Factors Altering the Absorption of Catgut, Surg., Gynec. & Obst. **63**: 561, 1936.
46. Fallis, L. S.: Postoperative Wound Separation: Review of Cases, SURGERY **1**: 523, 1937.
47. Harvey, S. C.: Concerning the Suture, Surg., Gynec. & Obst. **58**: 791, 1934.
48. Reil, H.: Beitrag zum Catgutproblem, Chirurg. **4**: 17, 1932.
49. Marchesani, O.: Ueber Catgutanaphylaxie. Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **49**: 233, 1932.
50. Gratia, A., and Gilson, O.: Le phénomène d'Arthus au catgut cause insoupçonnée d'accidents post-opératoires, Bull. Acad. roy. de méd. de Belgique **14**: 125, 1934.
51. Frugoni, P.: Sulla supposta allergia da catgut, ricerche sperimentali, Arch. ital. di chir. **43**: 334, 1936.
52. Moriconi, L.: Ricerca di Proprietà Antigene del Catgut, Rassegna internaz. di clin. e terap. **14**: 942, 1933.
53. Babcock, W. W.: Catgut Allergy, Am. J. Surg. **27**: 67, 1935.
54. Tripp, H. D.: Catgut Allergy, J. Indiana M. A. **28**: 383, 1934.
55. Kraissl, C. J.: Personal Communication.
56. Kraissl, C. J., Kesten, B. M., and Cimiotti, J. G.: The Relation of Catgut Sensitivity to Wound Healing, Surg., Gynec. & Obst. **66**: 628, 1938.
57. Bodansky, M.: Introduction to Physiological Chemistry, ed. 3, New York, 1934, John Wiley & Sons, Inc.
58. Gortner, R. A.: Outlines of Biochemistry, New York, 1929, John Wiley & Sons, Inc.
59. Ziegler, P. F., and Clark, G. L.: The X-Ray in the Study of the Catgut Ligature, Surg., Gynec. & Obst. **58**: 678, 1934.
60. Pickrell, K. L.: Studies on Hypersensitivity to Catgut as a Factor in Wound Disruption, Bull. Johns Hopkins Hosp. **64**: 195, 1939.
61. Freeman, L.: The Cause of Postoperative Rupture of Abdominal Incisions, Arch. Surg. **14**: 600, 1927.
62. Starr, A., and Nason, L. H.: Postoperative Rupture of Abdominal Wounds, J. A. M. A. **100**: 310, 1933.
63. Erdmann, J. F.: The Recognition and Treatment of Postoperative Complications, South. Surgeon **2**: 197, 1933.
64. Heyd, C. G.: Disruption of Abdominal Wounds, Ann. Surg. **99**: 39, 1934.
65. Heyd, C. G.: Ibid. Discussion by S. C. Harvey.
66. Baldwin, J. F.: Disruption of Abdominal Wounds, Am. J. Surg. **25**: 7, 1934.
67. Singleton, A. O.: The Anatomic Importance of Fascia in the Abdominal Wall, South. Surgeon **3**: 235, 1934.
68. Pickrell, K. L.: The Effect of Alcoholic Intoxication and Ether Anesthesia on Resistance to Pneumococcal Infection, Bull. Johns Hopkins Hosp. **63**: 238, 1938.
69. Langston, H. T.: The Problem of Catgut Sensitivity and Its Relation to Wound Healing, Ann. Surg. **115**: 141, 1942.

Review of Recent Meetings

REPORT OF THE MEETING OF THE SOUTHERN SURGICAL ASSOCIATION, DEC. 7-9, 1943, NEW ORLEANS, LA.

ROBERT E. CONE, M.D., GALVESTON, TEXAS

THE fifty-fifth annual session of The Southern Surgical Association was held at the Roosevelt Hotel in New Orleans, La., Dec. 7, 8, and 9, 1943, during the course of which thirty-seven scientific papers were presented.

W. H. Parsons, and (by invitation) **John C. Henthorne,** Vicksburg, Miss., reviewed the problem of bone-forming tumors in soft parts, reporting their experience with a patient with osteogenic sarcoma of the lower lip. The authors emphasized the value of careful study of biopsies histologically and the difficulties of differentiating myositis ossificans.

W. L. Estes, Jr., and (by invitation) **B. A. Bennett, Jr.,** Bethlehem, Pa., reported on eighty cases of perforation in peptic ulcer. In 38 per cent of their series no evidence of pneumoperitoneum was demonstrable. In 76 per cent simple closure was done. In 18 per cent excision and closure were done, in 18 per cent excision and closure with pyloroplasty, and closure and gastroenterostomy in 4 per cent. After purse-string closure with two rows of infolding stitches, the authors noted no excessive encroachment upon the lumen of the duodenum. It was pointed out that re-perforation may occur after any type of treatment and this was noted in 12 to 13 per cent of their group.

Frank H. Lahey, and (by invitation) **Samuel F. Marshall** of Boston reported their experiences with seventy-three cases of total gastrectomy, indicating the value of this procedure in selected instances. The authors favor the abdominal approach and usually remove also the spleen and omentum.

Charles A. Vance of Lexington reviewed the literature and reported personal experiences with twenty-seven cases of congenital pyloric stenosis, urging early recognition and preoperative preparation, prompt operation, and careful postoperative care.

J. Shelton Horsley, Richmond, Va., described his technique in resection of the colon by means of the Mikulicz operation plus enteroenterostomy with a rubber band, in an effort to combine safety with the elimination of a second stage operation for colostomy closure.

Isidore Cohn of New Orleans reported two cases of carcinoma of the duodenum, calling attention to the insidious development of this lesion and to the altered mucosal pattern on x-ray study.

J. Barrett Brown (Lt. Col., Medical Corps), and (by invitation) **Frank McDowell** of St. Louis illustrated their technique for block dissection of the cervical lymph glands in carcinoma of the mouth, lip, and tongue.

Received for publication, Jan. 3, 1944.

W. B. Russ of San Antonio described the working of the OCD nonprofit blood bank for civilians, emphasizing its usefulness.

The Association's president, **Barney Brooks** of Nashville, in his presidential address, reviewed the development of surgery, calling attention to the importance of studying the patient from a psychic as well as a somatic standpoint.

Walter E. Dandy of Baltimore discussed the newer aspects of ruptured intervertebral disks, stating that 98 per cent are diagnosable clinically without intraspinal media injections, and that nearly all can be cured by complete removal of the disk.

Paul B. Magnuson of Chicago discussed the differential diagnosis of causes of pain in the lower back accompanied by sciatic pain. In his opinion, backache with sciatic pain is not as simple a problem as it has been made to appear and requires careful differential study.

Guy A. Caldwell of New Orleans discussed the diagnosis and treatment of spondylolisthesis. He called attention to the fact that only 10 per cent of individuals with low back pain had spondylolisthesis. He described the mechanism of pain production and emphasized the importance of adequate x-ray visualization. Results following conservative and operative management were compared.

Nathan Womack, and (by invitation) **Heinz Haffner** of St. Louis indicated the significance of cholesterolosis in badly damaged gall bladders, stating that in view of the irritating nature of cholesterol and bile salts, a chemical cholecystitis was demonstrable in one-third of the cases coming to surgery, indicating that inflammatory changes may be secondary to chemical irritation.

R. S. Sanders of Memphis studied 575 patients with gall bladder and common bile duct disease with especial reference to indications for surgery of the common duct.

A. O. Singleton, and (by invitation) **M. D. Knight** of Galveston reviewed the history and embryology of congenital tracheo-esophageal fistulas and reported the successful closure through a right-sided transpleural approach following gastrostomy.

Harry Lee Archer (by invitation), and **Edwin P. Lehman,** Charlottesville, Va., confirmed the observations of Firor and Poth in the clinical and laboratory use of succinylsulfathiazole. Thirty-six patients were given this drug in preparation for operations on the large bowel with benefit and notable freedom from systemic reactions.

Joseph D. Collins, Portsmouth, Va., presented a case of neurofibroma of the small intestine, calling attention to existing confusion in terminology and to the rarity of benign neoplasms in this location.

William H. Prioleau, Charleston, S. C., reported two cases of massive resection of the small intestine. Case 1, with volvulus, survived resection of 260 cm. of small intestine and 31 cm. of large bowel. Case 2, with volvulus, survived after removal of 354 cm. of small intestine and 40 cm. of large bowel, but died later following a recurrent obstruction.

Curtice Rosser, of Dallas, described the simple nonspecific penetrating ulcer of the cecum, emphasizing the difficulties of recognition and the importance of closure and drainage.

Warren H. Cole, and (by invitation) **Lewis J. Rossiter** of Chicago, in a discussion of chronic cystic mastitis, indicated classification into four major types:

first, adenofibrosis, second, parenchymatous hyperplasia, third, precancerous hyperplasia, fourth, cystic disease. In their series of seventy-six cases, malignant transformation occurred in none of type one, in 3 to 10 per cent of type two, 20 to 30 per cent in type three, and 2 to 4 per cent in type four.

Alfred Blalock, and (by invitation) **Edwards A. Park** of Baltimore presented the surgical treatment of experimental coarctation (atresia) of the aorta. Ten of forty-three dogs survived after section of the aorta with closure of the ends followed by anastomosis of the subclavian into the side of the aorta.

John J. Martin, and (by invitation) **Merle Scott,** Rochester, N. Y., reported the successful ligation of the abdominal aorta for dissecting aneurysm of the left common iliac.

Rudolph Matas of New Orleans reported his personal experiences in the surgical treatment of aneurysms of the lower extremities, emphasizing the importance of collateral circulation and intrasaccular suture.

Mims Gage (Lt. Col., Medical Corps) discussed the simplicity of the Matas endo-aneurysmorrhaphy, calling attention to the importance of testing the collateral circulation and to developing it when necessary.

D. C. Elkin (Lt. Col., Medical Corps), and (by invitation) **Barnes Woodhall** (Major, Medical Corps), Atlanta, Ga., in discussing combined vessel and nerve war injuries, stressed the necessity for careful examination and called attention to the fact that vascular lesions may develop slowly.

Howard Mahorner of New Orleans discussed the control of pain in posttraumatic and other vascular disturbances, emphasizing the relief of vasospasm following sympathetic injection by the Lariche method.

H. J. Warthen, Jr. (Major, Medical Corps), Richmond, Va., discussed the treatment of burns complicated by fracture, with particular reference to compression dressings and skeletal traction.

John E. Cannady, Charleston, West Va., presented a report of the healing of wounds as influenced by sulfonamide therapy and the use of cotton thread sutures. The author indicates a preference for sulfathiazole crystals in small amounts and is convinced that cotton sutures are less irritating than catgut, silk, or nylon.

Cobb Pilcher of Nashville, in a discussion of the chemotherapy of intracranial infections, reported observations on the use of sulfonamides and of penicillin under various experimental conditions. He concluded that the sulfonamides were irritating and produced convulsions often and although helpful in meningitis were of no benefit for encapsulated infections or brain abscesses. The intrathecal use of penicillin was safe and beneficial.

F. A. Coller of Ann Arbor discussed chloride intoxication. He stated that because some individuals have subnormal chloride levels the administration of sodium chloride solutions must be carefully watched and toxic symptoms recognized clinically.

Charles G. Heyd of New York, in a description of voice disabilities following thyroid surgery, reported a variety of speech and breathing defects following injury to the recurrent laryngeal nerve or its divisions. Dr. Heyd reviewed the physiology and anatomy of the larynx and pointed out that 5 to 10 per cent of normal individuals have unilateral vocal cord paralysis.

J. Garland Sherrill, Louisville, Ky., discussed poliomyelitis and allied lesions of the cord and meninges.

K. H. Aynesworth, Waco, Texas, in a discussion of the McBurney incision in acute appendicitis, called attention to the lack of agreement in regard to the surgical approach to the appendix, stating that since in 20 per cent of cases the appendix is abnormally situated, preoperative efforts to detect abnormalities of location should influence surgeons in their approach. He emphasized clean cutting as against tearing of the abdominal wall.

Edgar Burns of New Orleans discussed the modern management of diverticula of the urinary bladder, calling attention to the importance of bladder neck obstruction and complete urologic investigation. Three patients with neoplasms in diverticula were presented.

Robert E. Cone of Galveston discussed the management of cryptorchidism, with particular reference to the usefulness of the Keetly-Torek operation. Classification of cryptorchids permits judicious application of treatment, hormonal or surgical. Because of the possibility of natural descent, observation with postponement of surgery until puberty or shortly thereafter was advocated.

Joseph A. Danna of New Orleans, in a report of interesting experiences with ether anesthesia, noted that in several instances surgical anesthesia lasted for varying periods (as much as one and one-half hours) after open-drop administration was stopped. The clinical applications of this phenomenon were discussed.

Book Reviews

Urology in General Practice. By Nels F. Ockerblad and Hjalmar E. Carlson. Pp. 383, with 97 illustrations. Chicago, 1943, Year-Book Publishers, Inc.

This is another textbook of urology in abbreviated form. Within its limitations of space it is, in a sense, excellent. The commoner ailments of the male urogenital system are well covered, and it contains so many practical suggestions concerning treatment, that students, practitioners, and urologists will find it worth-while reading.

On the other hand, it is pretty arbitrary in many respects, and does not encourage the uninitiated reader to form any opinions of his own, nor to look further for information. The authors have undertaken to perpetuate the legend that sudden emptying of the chronically distended bladder is dangerous. Their habit of recommending three tablets of somebody's proprietary remedy a day instead of using the more formal terminology and giving the dosage in some system of weights and measures, while concise, is not in line with the best current practice.

Many urologists of experience will dispute their statement that treatment with the high voltage x-ray is of no value in vesical neoplasms. Exceptions are at least numerous enough to make this a harmful remark in a book aimed at the general practitioner.

One cannot but wonder at the source of the authors' impression that all the results of castration in the 1890's for obstruction at the vesical neck were satisfactory, "the prostate returning to normal size in every instance." Is this sarcasm? If it were true, the operation could hardly have been abandoned so completely. The reviewer feels that a book on urology for the general practitioner should not only mention the urea splitting bacteria in stone formation, but should point out that they usually follow instrumentation by a physician, and particularly misuse of an inlying catheter. One misses, also, any helpful suggestions on the treatment of the tabetic bladder.

Essentials of Proctology. By Harry E. Bacon. Pp. 361, illustrations 168. Philadelphia, 1943, J. B. Lippincott Co. $3.50.

This is a volume of 361 pages with a foreword by Dr. Curtice Rosser. The material is presented very clearly and the book contains an adequate number of very good illustrations.

An interesting feature of this volume is the very complete index of signs and symptoms which is found on the fly page. This feature adds much to the value of the book and could well be duplicated by other authors.

Dr. Bacon has devoted sufficient space in discussing the anatomy, embryology, and physiology of the anus and rectum without burdening the reader with too much detail. The author covers all of the ordinary types of anorectal pathology as well as the differential diagnosis of the related diseases. Emphasis, upon the more important types of perirectal abscesses and fistulas and their treatment, is well made.

An entire chapter is devoted to tuberculosis of the anorectal region. This serves its purpose well in demonstrating the differentiation between tuberculous ulceration, ulcerative colitis, amebic dysentery, and hyperplastic tuberculous stricture, and malignancy.

The chapter on hemorrhoids is covered very well and is well illustrated. The injection treatment of internal hemorrhoids is discussed quite completely and the author's method of the surgical removal of hemorrhoids is described graphically.

In dealing with malignant tumors of the rectum and sigmoid colon, the author has given preference to the one-stage abdominoperineal procedure without colostomy as described by Babcock. The one-stage procedure of Miles is also described.

Dr. Bacon is an authority on lymphogranuloma venereum and in the text has devoted considerable space to the discussion of this disease. One cannot read this chapter without being impressed with the fact that too often many cases of this disease are missed.

Altogether, this book is a comprehensive manual of anorectal disease and compares favorably with the author's previous book, *Anus, Rectum, Sigmoid Colon.* The text can be well recommended to interested readers.

The Hospital Care of the Surgical Patient. By George Crile, Jr., and Franklin L. Shively, Jr., Cleveland Clinic, with a foreword by Evarts A. Graham. Pp. 184, with 21 illustrations. Springfield, Ill., 1943. Charles C Thomas, Publisher. $2.50.

This little book was intended primarily as an aid to the beginning house officer, and in most respects it should serve admirably for this purpose. It describes in most practical fashion the relationship that should exist between interns and nurses, between interns and staff members of hospitals, and between interns and the patient.

It outlines in brief and clear fashion the procedures which the intern might be called upon to do. Most of these procedures are described in modern and generally accepted fashion, but a few are not. There is no material on the blood or plasma bank, and the method of drawing blood from donors is the old open one rather than one of the closed ones which have generally been found necessary to prevent contamination and allow preservation of blood for days or of plasma for longer periods. Hot-water bottles and warm blankets are recommended for the treatment of shock, a practice now generally and properly abandoned. The use of inlying nasal gastric tubes for several days before operation is blamed for a very high incidence of postoperative pulmonary complications, a conclusion not reached in many other clinics.

Despite the faults which have been listed, the majority of the procedures and the bulk of the discussion are accurate, concise, and easily readable. This book is a very helpful addition to the armamentarium of the intern.

Surgery of Modern Warfare. By sixty-five contributors, Edited by Hamilton Bailey. Ed. 1. Pp. 899, with 828 illustrations, in two volumes. Baltimore, 1941, Williams & Wilkins Company. $10.00.

These two volumes embrace the entire range of traumatic surgery. The various sections are written by men who have had firsthand experience in the management of the wounded. The volumes contain accounts relating to projectiles and their effects upon various tissues; the organization of first-aid and emergency medical services; transportation of the wounded; shock, its causes and management; the localization of foreign bodies; the choice of anesthetic agent and satisfactory sections on all regional types of injury incident to warfare. Volume II concludes with an appendix of 50 pages containing up-to-the-minute last available surgical reports from the various Allied sectors.

These two volumes can be recommended as constituting the current military practices by our English surgical colleagues. The whole range of military surgery is discussed by surgeons who have had firsthand contact with care of the wounded in World War II.

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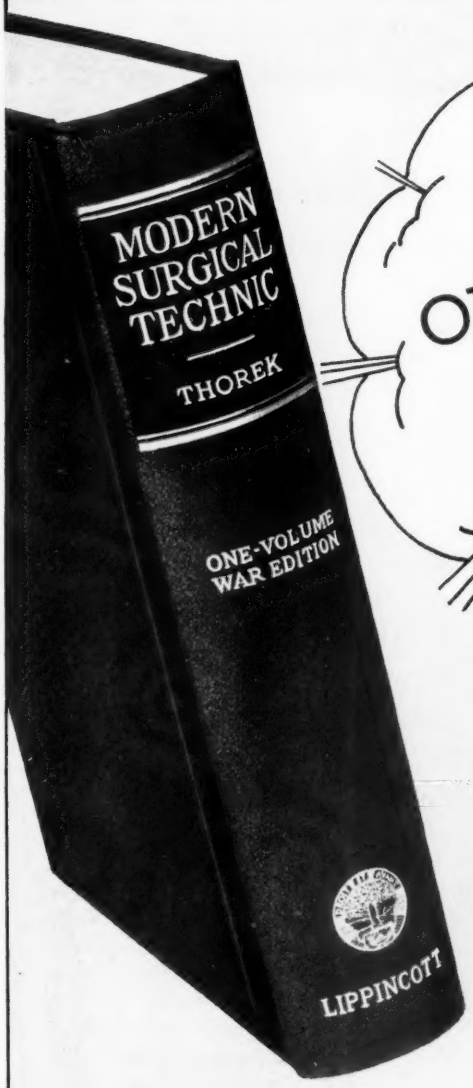

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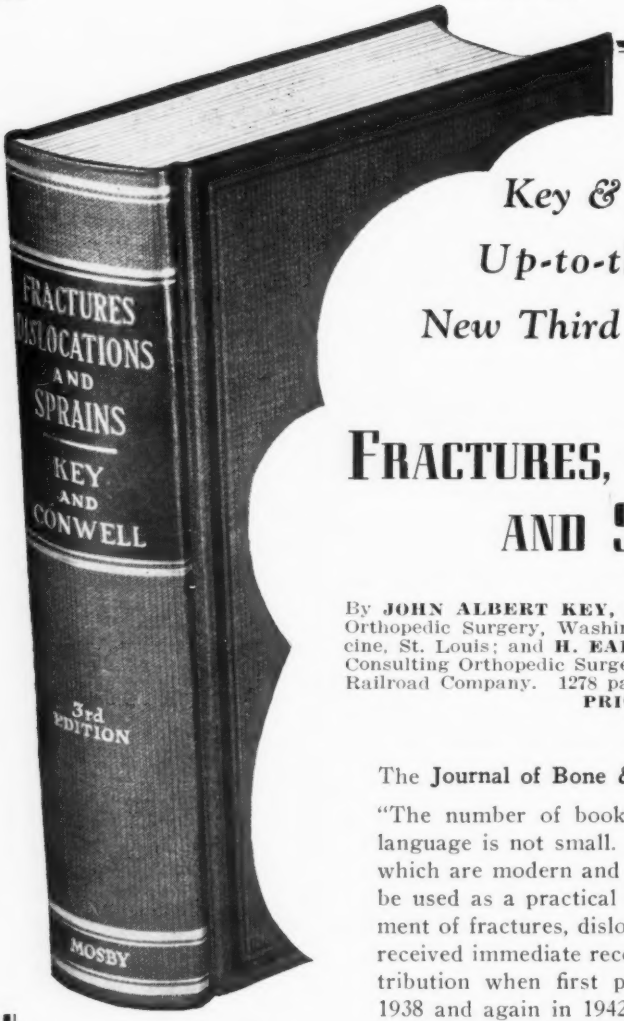

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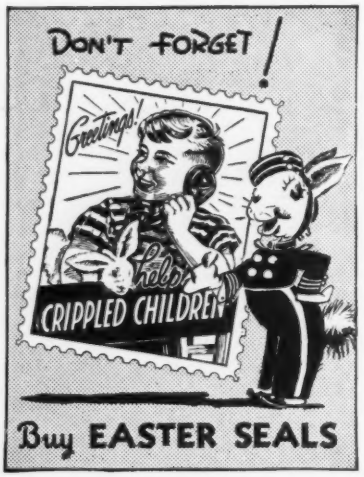

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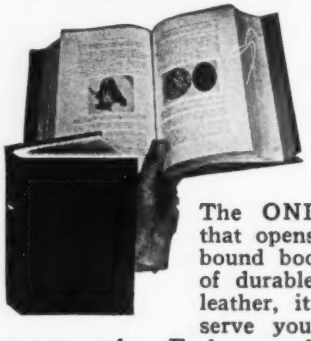

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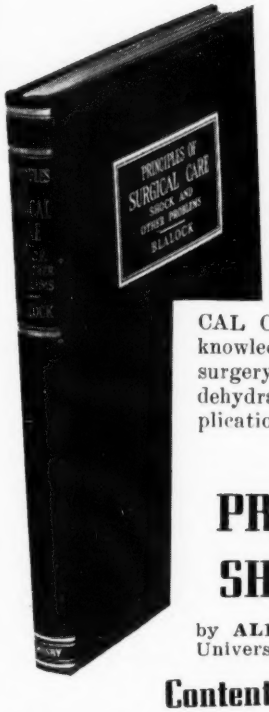

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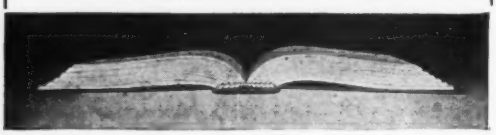

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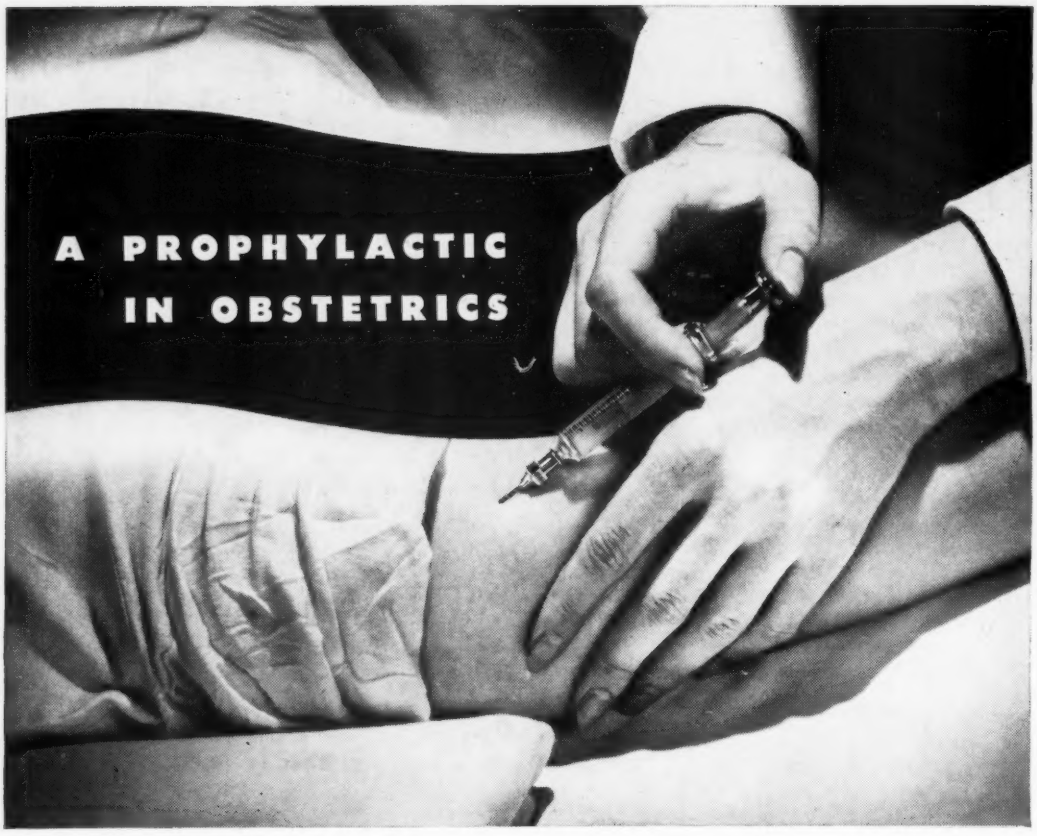

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